NORICAL: Denmark. Dan. Fisk. Hav.
.5, no. 5 predd. Serie: Fisk.

LIBRARY
FISH & WILDLIFE SERVICE
PACIFIC OCEANIC FISHERY
INVESTIGATIONS

# MEDDELELSER

FRA

# KOMMISSIONEN FOR HAVUNDERSØGELSER

SERIE: FISKERI · BIND V

---

NR. 5. P. JESPERSEN: CONTRIBUTIONS TO THE LIFE-HISTORY OF THE NORTH ATLANTIC HALIBUT (HIPPOGLOSSUS VULGARIS, FLEM.). WITH 1 PLATE AND 16 FIGURES IN THE TEXT

---

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
BIANCO LUNOS BOGTRYKKERI
1917

## MEDDELELSER FRA KOMMISSIONEN FOR HAVUNDERSØGELSER

### Serie: Fiskeri.

Bd. I, Nr. 1 C. G. Joh. Petersen: On the larval and post-larval stages of the Long Rough Dab and the Genus Pleuronectes. 2 Plates. 1904. 13 p. Kr. 1.00.

» I, » 2 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery I. 12 Plates. 1905. 70 p. Kr. 5.25.

» I, » 3 Johs. Schmidt: On pelagic post-larval Halibut. (Hippoglossus vulgaris Flem. and H. hippoglossoides Walb.) 1 Plate. 1904. 13 p. Kr. 0.75.

» I, » 4 Johs. Schmidt: De atlantiske Torskearters (Gadus-Slægtens) pelagiske Yngel i de post-larvale Stadier. Med 3 Tavler og 16 Figurer. 1905. 74 S. Kr. 3.00.

» I, » 4 Johs. Schmidt: The pelagic post-larval stages of the Atlantic Species of Gadus. A Monograph with 3 Plates and 16 Figures in the Text. 1905. 77 p. Kr. 3.00.

» I, » 5 C. G. Joh. Petersen: Larval Eels. (Leptocephalus brevirostris) of the Atlantic coasts of Europe. 1905. 5 p.

» I, » 6 A. C. Johansen: Remarks on the life history of the young post-larval Eel (Anguilla vulgaris Turt.) 1904. 9 p. Kr. 0.50.

» I, » 7 Adolf Sev. Jensen: On fish-otoliths in the bottom-deposits of the Sea. I. Otoliths of the Gadus-Species deposited in the Polar Deep. 4 Fig. 1905. 14 p. Kr. 0.50.

» I, » 8 Johs. Schmidt: On the larval and post-larval stages of the Torsk (Brosmius brosme [Ascan.]). 1 Plate. 1905. 12 p. Kr. 0.75.

» II, » 1 C. G. Joh. Petersen: On the larval and post-larval stages of some Pleuronectidæ (Pleuronectes, Zeugopterus.) 1 Pl. 1906. 10 p. Kr. 0.50.

» II, » 2 Johs. Schmidt: The pelagic post-larval stages of the Atlantic species of Gadus. A monograph. Part II. 1 Pl. 1906. 20 p. Kr. 1.00.

» II, » 3 Johs. Schmidt: On the pelagic post-larval stages of the Lings (Molva molva [Linné] and Molva byrkelange [Walbaum]). With 1 Pl. and 3 Figures. 1906. 16 p. Kr. 0.75.

» II, » 4 Johs. Schmidt: On the larval and post-larval development of the Argentines (Argentina silus [Ascan.] and Argentina sphyræna [Linné]) with some Notes on Mallotus villosus [O. F. Müller]. 2 Pl. 1906. 20 p. Kr. 1.50.

» II, » 5 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. II. The marking and transplantation experiments with Plaice in the years 1903—06. 6 Pl. and 10 Figures. 1907. 122 p. Kr. 5.25.

Bd. II, Nr. 6 Johs. Schmidt: Marking experiments on Plaice and Cod in Icelandic waters. 2 Charts. 23 p.

» II, » 7 Johs. Schmidt: On the post-larval development of the Hake (Merluccius vulgaris Flem.) 1 Pl. 4 Figures. 1907. 10 p. Kr. 1.75.

» II, » 8 Johs. Schmidt: On the post-larval development of some North Atlantic Gadois (Raniceps raninus [Linné] and Molva elongata [Risso]). 1 Pl. and 1 Fig. 1907. 14 p. Kr. 0.75.

» II, » 9 Johs. Schmidt: On the post-larval stages of the John Dory (Zeus Faber L.) and some other Acanthopterygian Fishes. 1 Plate. 1908. 12 p. Kr. 0.75.

» III, » 1 C. G. Joh. Petersen: On the larval and post-larval stages of some Pleuronectidæ (Zeugopterus, Arnoglossus, Solea.) 2 Plates. 1909. 18 p. Kr. 1.25.

» III, » 2 I. P. Jacobsen and A. C. Johansen: Remarks on the changes in specific gravity of pelagic fish eggs and the transportation of same in Danish waters. 2 Text-Figures. 1908. 24 p. Kr. 0.75.

» III, » 3 Johs. Schmidt: Remarks on the metamorphosis and distribution of the larvae of the Eel (Anguilla vulgaris Turt.) 1 Pl. and 1 Chart. 1909. 17 p. Kr. 1.00.

» III, » 4 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. III. On the variation in frequency of young Plaice in Danish waters in 1902—07. 12 Figures. 1908. 48 p. Kr. 1.50.

» III, » 5 A. C. Johansen: Do. do. do. IV. Is the Plaice indigenous to the true Baltic? 2 Fig. 1908. 23 p. Kr. 0.75.

» III, » 6 Johs. Schmidt: On the occurrence of Leptocephali (Larval Muraenoids) in the Atlantic W. of Europe. 2 Pl. & 1 Chart. 1909. 19 p. Kr. 1.50.

» III, » 7 Johs. Schmidt: On the distribution of the fresh-water Eels (Anguilla) throughout the world. I. Atlantic Ocean and adjacent regions. A bio-geographical investigation. 1 Chart. 1909. 45 p. Kr. 1.75.

» III, » 8 A. C. Johansen: Bericht über die dänischen Untersuchungen über die Schollenfischerei und den Schollenbestand in der östlichen Nordsee, dem Skagerak und dem nördlichen Kattegat. Mit 10 Figuren im Text. 1910. 142 S. Kr. 4.50.

» IV, » 1 A. C. Johansen: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. V. The supposed migrations of plaice from the Kattegat and Belt Sea to the true Baltic. 5 Figures. 1912. 34 p. Kr. 1.25.

MEDDELELSER FRA KOMMISSIONEN FOR HAVUNDERSØGELSER
SERIE: FISKERI · BIND V · NR. 5 · 1917

# CONTRIBUTIONS TO THE LIFE-HISTORY

OF

# THE NORTH ATLANTIC HALIBUT

(*HIPPOGLOSSUS VULGARIS*, FLEM.)

BY

P. JESPERSEN

WITH 1 PLATE AND 16 FIGURES IN THE TEXT

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
BIANCO LUNOS BOGTRYKKERI
1917

# I. Introduction.

Among the economically important fishes found in Iceland waters, the Halibut (*Hippoglossus vulgaris* Flem.) takes a prominent place.

It is met with in great quantities both at the Færoes and Iceland, in fairly shallow water as well as out at greater depths. In Iceland waters, most of the halibut are taken in the trawl, at 30—60 m.; they may, however, also be encountered in far deeper spots, as is shown by the capture of a specimen in 920 metres of water, south of the Vestmanna Islands (Thor's St. 170, 1903). It is met with on all the coasts of Iceland, though probably in greatest numbers to the south and west. An intensive halibut fishery is carried on both at Iceland and the Færoes, but in both cases the greater part of the yield falls to foreign vessels. England has even started a special fishery with long-line steamers, chiefly directed towards the capture of halibut; apart from this, however, quantites of the fish, more especially the smaller sizes, are taken by trawlers of various nationalities. A similar long-line fishery was carried on for some years by American schooners, but this fishery has now apparently ceased altogether; as far back as 1903 there were only a couple of American vessels working off the coast of Iceland. (Johs. Schmidt 1904 b). Further information as to the British long-line fishery will be found for instance in Johs. Schmidt: Fiskeriundersøgelser ved Island og Færøerne i Sommeren 1903.

It will doubtless be worth while to investigate what may be the importance of the halibut fishery in Northern Europe, what nations participate therein, and which fishing grounds take foremost rank. As a basis for such investigations, I have had recourse to the "Bulletin statistique des pêches maritimes des pays du nord de l'Europe", utilising the material furnished by the statistics for 1910 to give an idea as to the importance of the fishery. From the following pages, it will be directly seen what part the various fishing grounds play in the halibut fishery, and to what extent the different nationalities participate in the same. The statistics for Norway are unfortunately not so full as was to be desired, and it is possible that a considerable part of the catch recorded as from the Norwegian Sea should in reality be ascribed to the Færoes. The position of these two grounds in the table is therefore somewhat uncertain.

England is indisputably first among the various nations here concerned, over half the total annual yield falling to English vessels. One fourth of the yearly catch is made by Scottish vessels, and about one-fifth by Norwegians. These three nationalities are far in advance of the rest, making up together 94—95 % of the total haul. Glancing then at the different fishing grounds, it will at once be noticed how markedly the Iceland fishery here predominates. The Norwegian Sea comes next; the exact place which should be accorded to this locality in the table is, however, as mentioned, somewhat uncertain. Next in order are the West Coast of Scotland and North coast of Ireland; after these, the Færoes and the North Sea. The five most important fishing grounds represent about 88 % of the total yield, half of which percentage again is contributed by Iceland.

The total yield amounted in 1910 to 14,058,762 kg. with a value of £ 456,909 (1 kg. = 0.78 shillings) or Mk. 11,247,009 (1 kg. = 0.80 Mark). It will be interesting in this connection to note the rise which has

**Importance of the Halibut Fishery for the different Nations and Fishing Grounds northern in Europe. 1910. Yield in kilos.**

| | England | Scotland | Norway | Germany | Denmark (Iceland) | Nether-lands | Russia | Belgium | Total Quantity | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Kg. | Percentage |
| Iceland | 4,631,741 | 927,933 | .. | 418,986 | 132,300 | 25,514 | .. | 10,916 | 6,147,390 | 43,72 % |
| Norwegian Sea | .. | .. | 1,884,754 | .. | .. | .. | .. | .. | 1,884,754 | 13,40 - |
| W.-coast of Scotland, N.-coast of Ireland | 487,731 | 1,174,976 | .. | 1,158 | .. | .. | .. | .. | 1,663,865 | 11,83 - |
| Færoes | 1,036,980 | 345,626 | .. | .. | .. | 2,448 | .. | .. | 1,385,054 | 9,85 - |
| North Sea | 233,172 | 826,607 | 127,616 | 83,146 | 6,858 | 49,486 | .. | .. | 1,326,885 | 9,43 - |
| Rockall | 446,684 | 326,123 | .. | .. | .. | .. | .. | .. | 772,807 | 5,49 - |
| Polar Sea | .. | .. | 331,137 | .. | .. | .. | .. | .. | 331,137 | 2,35 - |
| W.- and S.-coast of Ireland | 136,448 | .. | .. | .. | .. | .. | .. | .. | 136,448 | 0,97 - |
| Skager Rak | .. | .. | 101,292 | 33,794 | 10 | .. | .. | .. | 135,096 | 0,96 - |
| Barents Sea | 23,216 | .. | .. | .. | .. | .. | 11,280 | .. | 34,496 | 0,24 - |
| W.- and N.-coast of England | 6,807 | .. | .. | .. | .. | .. | .. | .. | 6,807 | 0,04 - |
| Kattegat | .. | .. | .. | 2,413 | .. | .. | .. | .. | 2,413 | 0,01 - |
| Bay of Biscay and southern waters | 153 | .. | .. | .. | .. | .. | .. | .. | 153 | 0.001- |
| Mixed regions | 224,688 | .. | .. | 6,769 | .. | .. | .. | .. | 231,457 | 1,64 - |
| Total ... | 7,227,620 | 3,601,265 | 2,444,799 | 546,266 | 139,168 | 77,448 | 11,280 | 10,916 | 14,058,762 | |
| Percentage ... | 51.41 % | 25.62 % | 17.39 % | 3.88 % | 0.99 % | 0.55 % | 0.08 % | 0.07 % | | |

taken place in the price of halibut during recent years. The English statistics give the following figures for 1904—1914.

The price per cwt. has thus risen to very nearly double in the course of ten years.

**Average value per cwt. of Halibut landed in England and Wales in each year from 1904 to 1914.**

| | £ | s | d |
|---|---|---|---|
| 1904 | 1 | 16 | 11 |
| 1905 | 1 | 16 | 11 |
| 1906 | 1 | 17 | 9 |
| 1907 | 1 | 13 | 8 |
| 1908 | 1 | 19 | 9 |
| 1909 | 2 | 5 | 4 |
| 1910 | 2 | 10 | 3 |
| 1911 | 2 | 13 | 8 |
| 1912 | 3 | 0 | 0 |
| 1913 | 3 | 5 | 6 |
| 1914 | 3 | 7 | 2 |

The various tables will in themselves suffice to show the great importance of the halibut fishery to several countries, as also the extremely prominent part played by the waters around the Færoes, and particularly Iceland, in this fishery. It is therefore matter for surprise that the halibut, despite its high economical value, is not included in the programme of the International Investigations. The reason of this must presumably be that the halibut is of but relatively slight importance to the fishing industry of the inner waters, such as the North Sea, the Skagerak, etc. These waters apart, however, and taking in consideration Iceland, the Færoes, Rockall and the coasts of Scotland and Ireland, it must be admitted that the halibut is of great economical importance to the fisheries. It should accordingly be worth while endeavouring to clear up various points in the biology of the species, many of which, indeed are still altogether unknown.

The first important contribution to the study of reproduction among halibut was, as we know, furnished in 1904 by Dr. Johs. Schmidt, in his reports on the finding of pelagic larval stages off the coasts of the Færoes and Iceland, during the cruise of the marine research steamer "Thor" in those waters. It was thereby demonstrated that the halibut must spawn in the Atlantic off these islands, but the larval stages have, as far as I am avare, never since been found elsewhere, and it is thus still an open question whether the halibut has other spawning grounds in North-European waters. The time at which spawning takes place has more recently been ascertained with some degree of certainty, but neither the eggs in a free state nor the earliest bottom stages can as yet be altogether certainly determined. Various points would seem to indicate that the halibut in Iceland waters undertake considerable migrations; up to the present, however, nothing is known as to how such movements take place.[1] Again, no investigations have hitherto been made as to the grovth of the halibut in these waters, the age at which

[1] Marking experiments with halibut have also been made by the Danish investigations, but have given no results up to now.

they attain maturity, etc. Altogether, it must be admitted that there are numerous questions which clearly need to be investigated.

The present work is intended as a contribution towards the elucidation of some of these features, which are of considerable biological importance, and is especially devoted to the consideration of the following points:

1. The size of the Iceland Halibut (length and weight).
2. Growth of the Iceland Halibut.
3. Statistics referring to the Halibut fishery in Iceland and Færoe waters.
4. Further contributions to the study of propagation and developement in Halibut.

During the years 1903—06 on the cruises of the "Thor" in Iceland and Færoe waters, Dr. Johs. Schmidt made occasional, and in 1908 systematic collections and investigations concerning the biology of the halibut. The material of otoliths collected on these cruises has since, at the instigation of Dr. Schmidt, been supplemented by Adjunkt Bjarni Sæmundsson, and in addition, Capt. G. Hansen was sent to Iceland in the summer of 1909 to procure material for age determination of the most important fishes, including the halibut.

In addition to the mentioned material of otoliths, the journals of the various cruises to Iceland and the Færoes form the basis upon which the present work has been compiled. The statistics are taken partly from the Fishery Reports of the various countries, and partly from the volumes issued of the "Bulletin statistique des pêches maritimes des pays du nord de l'Europe". Furthermore, at the request of Dr. Johs. Schmidt, we have received from Scotland an extensive amount of statistical material concerning the Scottish halibut fishery at Iceland and the Færoes. The material in question has been furnished partly by Professor D'Arcy W. Thompson, of Dundee, and partly from Mr. Walter Duff, of the Aberdeen Fishery Office, forwarded through the Fishery Board for Scotland (Mr. D. T. Jones) at the instigation of Dr. T. W. Fulton, of Aberdeen.

I take this opportunity of expressing my thanks to the Leader of the Fishery Investigations at the Færoes and Iceland, Dr. Johs. Schmidt, who has permitted me to deal with the present material, and has very kindly assisted me with all possible information throughout the work.

## II. Size of the Iceland Halibut (Length and Weight).

The halibut attains, as we know, a size far exceeding that of any other flounder species. Instances are frequently cited in the literature, of specimens greatly beyond the measurements and weight generally met with. These giant fish are, however, comparatively rare, though individuals of very respectable size are by no means uncommon in the waters about Iceland and the Færoes. The largest specimen taken on the Iceland cruise of the "Thor" measured 186 cm. total length, and weighed 98,000 gr. An even larger one, of which the otoliths are preserved, was taken at the Færoes. Its total length was 81 inches, or 213 cm.

As will subsequently be seen, the growth of the halibut is not uniform in the various waters off the coasts of Iceland. In ordinary comparison between total length and corresponding weight, however, it will hardly be necessary thus to discriminate between the different localities. In the lists given below, showing the average weight per cm. total length, only fish from the West and North-western coasts of Iceland have been included, no information being available as to the weights of halibut taken on the eastern side. In addition to the average weight, the range of variation for all specimens of the respective total lengths has also been noted.

A further illustration of the proportionate increase in weight with increasing length is afforded by the accompanying graphical chart (fig. 1), drawn up for specimens ranging from 20 to 90 cm. total length. It will here be noticed how surprisingly the weight advances per cm. of length as soon as the fish have reached a total length of 60—70 cm.

The average increment of weight per cm. total length for the various sizes is approximately as follows.

**Weight of Halibut at various lengths. Iceland.**

| Length cm. | No. of specimens | Average weight gr. | Range of variation gr. | Length cm. | No. of specimens | Average weight gr. | Range of variation gr. |
|---|---|---|---|---|---|---|---|
| 186 | 1 | 98000 | | 59 | 5 | 2069 | 1940—2190 |
| 176 | 1 | 75000 | | 58 | 3 | 1982 | 1840—2115 |
| 174 | 1 | 76500 | | 57 | 8 | 1934 | 1700—2205 |
| 154 | 1 | 49000 | | 56 | 9 | 1946 | 1780—2500 |
| 135—141 | 6 | 29795 | 23000—39000 | 55 | 4 | 1668 | 1370—1900 |
| 116—120 | 3 | 20758 | 19500—21880 | 54 | 3 | 1495 | 1440—1570 |
| 111—115 | 5 | 17133 | 15000—19250 | 53 | 3 | 1845 | 1700—1960 |
| 106—110 | 5 | 13909 | 11500—16000 | 52 | 7 | 1489 | 1350—1670 |
| 101—105 | 7 | 13095 | 11700—14850 | 51 | 5 | 1445 | 1330—1620 |
| 96—100 | 5 | 11187 | 9750—12250 | 50 | 2 | 1350 | 1260—1440 |
| 91—95 | 8 | 9363 | 8250—10500 | 49 | 1 | 1100 | .. |
| 90 | 2 | 8020 | 7500—8540 | 48 | 5 | 1413 | 1290—1550 |
| 89 | 3 | 7478 | 7200—7750 | 47 | 1 | 1180 | .. |
| 88 | 4 | 7350 | 6885—8250 | 46 | 5 | 1145 | 1040—1300 |
| 87 | 7 | 7192 | 6310—8500 | 45 | 4 | 955 | 820—1070 |
| 86 | 6 | 6452 | 5500—7500 | 44 | 7 | 974 | 845—1080 |
| 85 | 2 | 6125 | 6000—6250 | 43 | 15 | 920 | 775—1150 |
| 84 | 4 | 6057 | 5680—6500 | 42 | 13 | 854 | 710—990 |
| 83 | 3 | 6385 | 5620—7000 | 41 | 11 | 797 | 710—900 |
| 82 | 1 | 4790 | .. | 40 | 16 | 715 | 605—810 |
| 81 | 4 | 5338 | 5000—6270 | 39 | 21 | 656 | 570—860 |
| 80 | 4 | 5108 | 4600—5630 | 38 | 21 | 610 | 530—700 |
| 78 | 3 | 5235 | 5040—5500 | 37 | 28 | 558 | 430—680 |
| 77 | 6 | 5027 | 4720—5500 | 36 | 29 | 498 | 410—650 |
| 76 | 3 | 5122 | 5000—5300 | 35 | 29 | 448 | 400—550 |
| 75 | 8 | 4416 | 3900—5460 | 34 | 25 | 403 | 340—480 |
| 74 | 4 | 4260 | 3760—4620 | 33 | 28 | 364 | 320—420 |
| 73 | 4 | 4148 | 3820—4300 | 32 | 43 | 326 | 240—400 |
| 72 | 3 | 4528 | 4250—5000 | 31 | 50 | 288 | 250—350 |
| 71 | 6 | 3735 | 3420—4230 | 30 | 76 | 256 | 220—320 |
| 70 | 10 | 3677 | 3150—4500 | 29 | 35 | 236 | 200—310 |
| 69 | 7 | 3268 | 2950—3750 | 28 | 44 | 208 | 180—260 |
| 68 | 11 | 3240 | 2800—3950 | 27 | 28 | 187 | 160—230 |
| 67 | 6 | 3390 | 2900—4000 | 26 | 16 | 168 | 140—220 |
| 66 | 7 | 2801 | 2400—3110 | 25 | 16 | 155 | 130—200 |
| 65 | 7 | 2851 | 2640—3240 | 24 | 10 | 128 | 120—145 |
| 64 | 10 | 2750 | 2450—3500 | 23 | 14 | 112 | 105—140 |
| 63 | 9 | 2548 | 2000—3250 | 22 | 8 | 100 | 90—105 |
| 62 | 7 | 2528 | 2040—3000 | 21 | 5 | 80 | 80—80 |
| 61 | 7 | 2452 | 2150—2950 | 20 | 2 | 75 | 70—80 |
| 60 | 7 | 2539 | 1960—3000 | | | | |

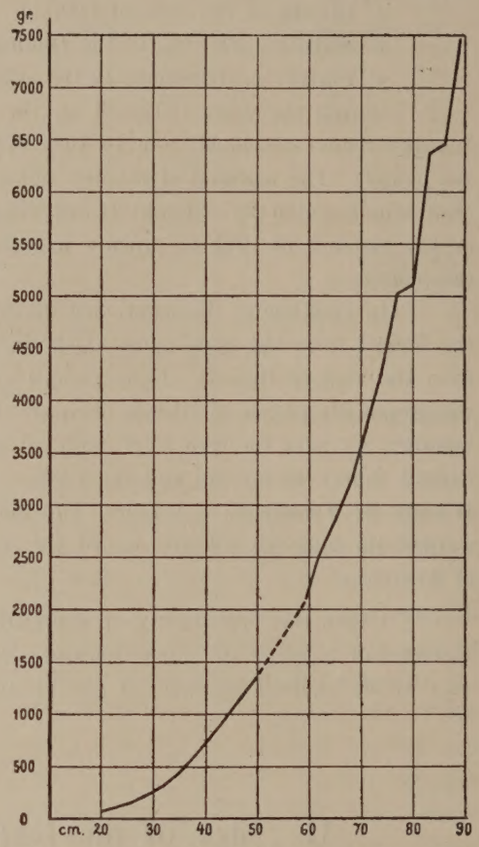



Fig. 1. Graphical Chart showing growth of the Iceland Halibut. Total length and weight.

**The average increment of weight per cm. total length for the various sizes.**

| | cm. | gr. |
|---|---|---|
| Total length | 25— 35 .... | 28.9 |
| — | 35— 45 .... | 50,7 |
| — | 45— 55 .... | 71.3 |
| — | 55— 65 .... | 118.3 |
| — | 65— 75 .... | 156.5 |
| — | 75— 85 .... | 170.9 |
| — | 85— 95 .... | 323.8 |
| — | 95—105 .... | 373.2 |
| — | 105—115 .... | 403.8 |

On further growth, the weight increment per cm. steadily increases, but the present material does not include sufficient number of large sizes to permit of our pursuing the calculation of average weight increment per cm. according to the same method. Some idea as to the comparatively enormous strides with

which the weight advances in the largest specimens may be gained from the fact that this works out roughly to an average of 1375 gr. per cm. for sizes between 154 and 174 cm., and 2300 gr. per cm. for 176—186 cm. It should be noted, however, that these figures are based on a very small number of specimens.

## III. Growth of the Iceland Halibut.

The material employed in this investigation as to the growth of the Iceland halibut consisted of otoliths from fish taken on board the marine research steamer "Thor" during the Iceland cruises of 1908 and 1909. In addition, a smaller number of otoliths collected by Adjunkt Bjarni Sæmundsson, of Reykjavik, from Halibut caught in Fakse Bugt during the autumn of 1909 and spring of 1910, have also been used. The following table shows the distribution of the 2921 fish from which the material was derived.

| | | | | |
|---|---|---|---|---|
| S. W.-Iceland | Faxebugt. | Taken by S/s "Snorri Sturluson" | 1667 spec. | |
| | — | — - marine research vessel "Thor" | 387 — | |
| | — | — - various Iceland cutters | 21 — | |
| | — | Collected by Adj. Sæmundsson | 104 — | |
| | | | | 2179 spec. |
| N. W.-Iceland | Bredebugt. | Taken by marine research vessel "Thor" | 58 spec. | |
| | — | — - S/s "Snorri Sturluson" | 57 — | |
| | Patrexfjord | | 289 — | |
| | Arnefjord | | 97 — | |
| | Ønundarfjord | | 100 — | |
| | Sugandafjord | | 45 — | |
| | | | | 646 spec. |
| East-Iceland. | Seydisfjord | | 87 spec. | |
| | Off Glettinganes | | 9 — | |
| | | | | 96 spec. |
| | | Total | | 2921 spec. |

After removal from the cranium, the otoliths were numbered and packed away in paper bags. The sex of the fish, its total length, and in most cases also the weight, were then noted against the corresponding number. In many instances the contents of stomach was likewise recorded, and for female specimens, the length of the ovary measured. The various data were at once entered on forms specially prepared for the purpose.

The otoliths of the halibut may generally be said to be well adapted for age determinations, showing far more distinctly than those of many other fish the annual rings on which the count is based. It has been found advantageous to clarify the otoliths, prior to examination, in glycerine or xylol. When then held up to the light, it has been found possible to read off the number of growth rings directly, by transmitted light. As a rule, a low power magnifying lens was used for readings. Generally, it was not found necessary to grind down the otoliths; in some few cases, however, where the number of rings was unusually high, this was done by way of experiment, but the results were not altogether satisfactory.

Both otoliths, right and left, of all specimens were preserved, and we find, as a constant feature, that there is a marked difference between the two in each case, the growth rings to the left otolith being always far more pronounced than those in the right. Practically speaking, this is as much as to say that for age determinations, the left otoliths should exclusively be employed.

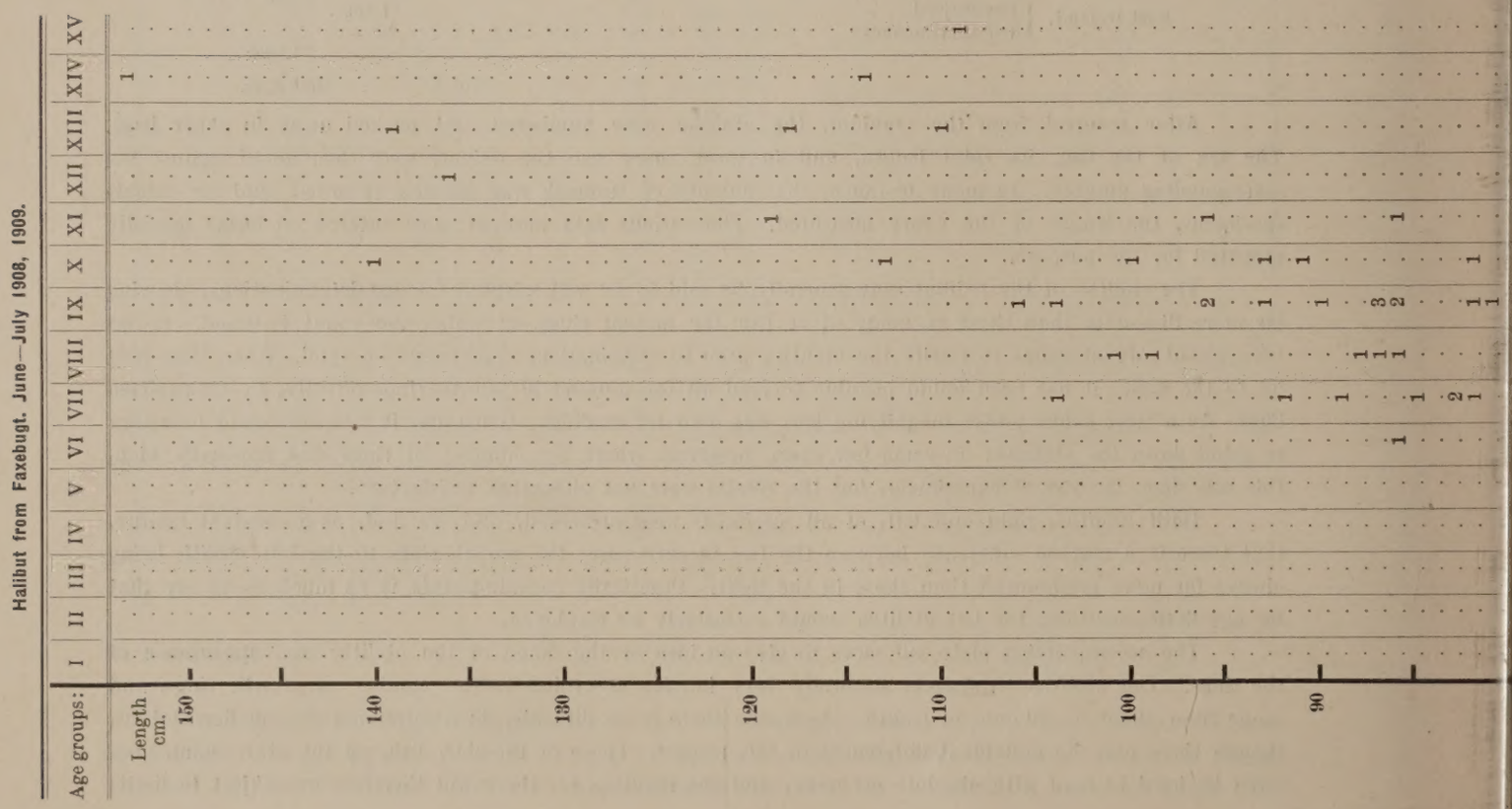
The accompanying plate vill serve to give an idea of the shape of the otoliths and appearance of the rings. The otoliths themselves naturally vary in size according to the number of growth rings, and range from about 5—20 mm. in length. As a rule there is no difficulty in determining the smaller otoliths, though there may be individual differences in this respect. Those of the older fish, on the other hand, may often be hard to read with absolute accuracy, and the readings for these will therefore be subject to limits

of possible error amounting to one or two years. Generally speaking, we may say that the age of fish below 50 cm. can be determined with certainty; in the case of fish from 50 to 110 cm., the results may not infrequently be somewhat doubtful (the possible error, however, hardly exceeding 1 year) while for specimens over 110 cm. any absolutely definite age determination will often be out of the question (limit of error 1—2 years). Out of the total quantity of material available, only 5—6 % proved unsuitable for the purpose of age determination, i. e. only in this percentage of cases did the limits of error exceed the figures above noted.

Before proceeding to apply the results of the age determinations, it will be best to point out at once that the present material does not afford any correct quantitative illustration of the yield from the various localities. The otoliths were taken partly by trawl and partly on lines, in addition to which, otoliths were often only taken from a small selection of the halibut in a haul. The trawl fishery, for instance, gives for the most part only smaller specimens, the III group in particular being numerously represented here. In several cases also, otoliths vere only taken from fish over 35 cm. and below 25 cm. between which limits lie the most frequently occurring sizes of the III group, the object of such selection being to prevent the group in question from taking too prominent a position, when only a small portion of a large haul could be utilised for collection of material.

In view of the considerable variation which has been observed in the growth of halibut from the different coasts of Iceland, it will be best to treat each locality separately. After going through the material, and preliminary comparison of the results, I have found it most convenient to make three sections; viz:

1. South-west Iceland (Faxe Bugt).
2. North-west Iceland (Bredebugt, Patrex-, Arne-, Ønundar- and Sugandafjords).



3. East Iceland (Seydisfjord, and off Glettinganes).

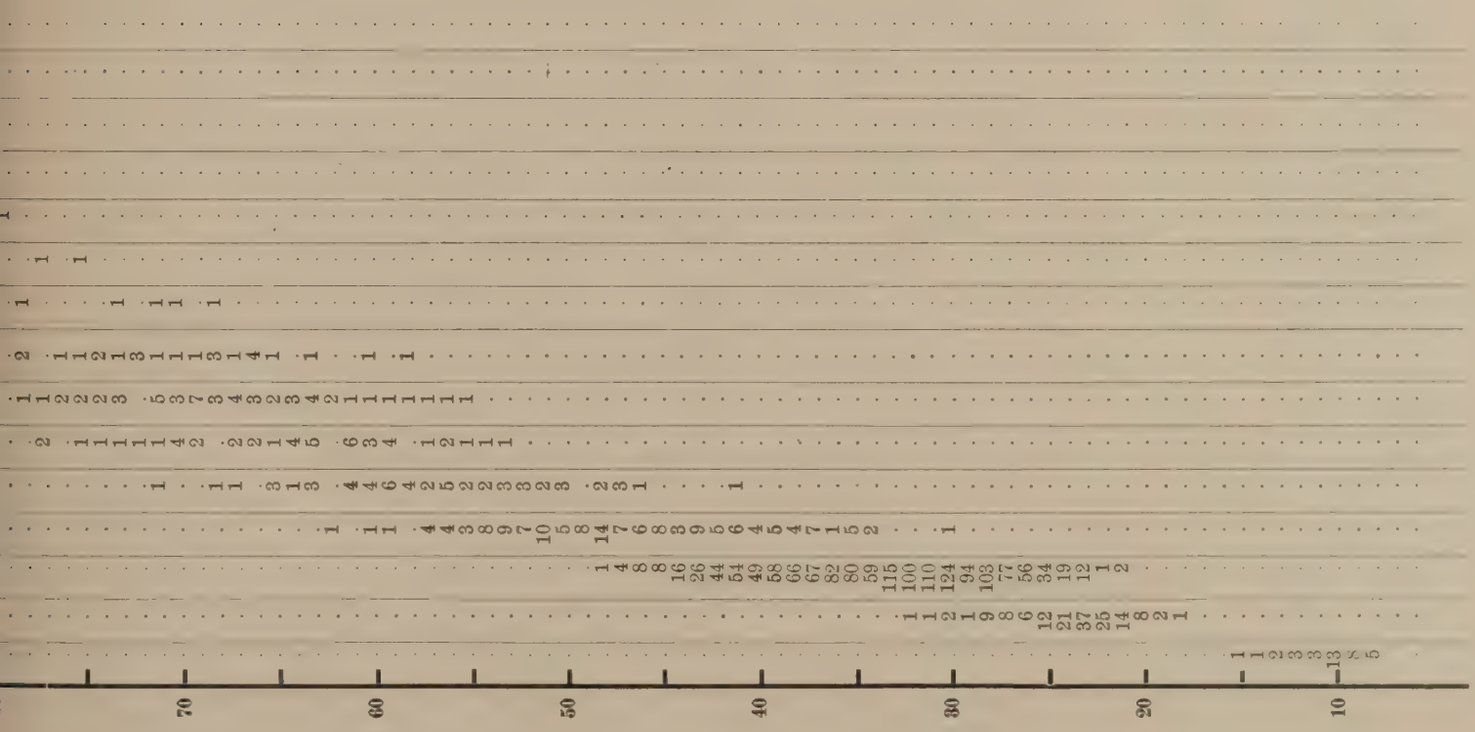
A consideration of these three localities, with a general comparison of the conditions there prevailing, will give the lines on which the growth investigations are here set forth.

## 1. South-west Iceland.

As will be seen from the general survey of the material, by far the greater part of the otoliths collected were from Faxe Bugt; this fjord will therefore be made the subject of more detailed consideration.

The total number of otoliths from Faxe Bugt found suitable for age determinations, amounted to 2719, the various year-groups being represented in the proportions shown in the graphical chart. The III group is here markedly predominant over the others, which is due, at any rate in part, to the fact that the greater portion of the material was taken in the trawl, and thus consisted mainly of smaller sizes than those generally brought in by the line fishery. The I and II groups are but poorly represented in comparison, the reason of which is presumably that these year-classes are for the most part found in shallow water. The older year-groups were taken either by trawl or by line; the latter in particular accounting for most of the oldest specimens.

The entire amount of material is derived from hauls made during the months of June and July, the smaller quantity collected by Adjunkt Bjarni Sæmundsson at other seasons not being here included. Halibut of the 0-group, i. e. pelagic post-larval stages, have at this time of year a length of 1—3 cm., and it will also be noticed that the three youngest groups fall in point of size entirely clear one of another. The figures for the three groups in June-July are as follows:



| | | | | | | |
|---|---|---|---|---|---|---|
| 0-group: | Average length | abt. | 2 cm. | varying from | 1— 3 | cm |
| I-group: | — | — | 10 - | — | — 8—15 | - |
| II-group: | — | — | 23 - | — | — 18—32 | - |

The range of variation then for the 0, I and II groups is so slight that the three in no case overlap. It is otherwise, however, with the II and III groups, the range of variation of the last-named being so wide that the greater portion of the II group also falls within its limits. The older year-classes overlap still more, and it will thus be understood that the length of the fish in reality tells us very little as to the exact age of the fish, save in the case of the two youngest groups.

The range of variation for total length within the various year-groups increases more or less gradually, being comparatively slight for young specimens, but extending in the older groups, as is shown by the difference between the extreme limits of variation for the groups most fully represented.

| Age group... | 0 | I | II | III | IV | V | VI | VII |
|---|---|---|---|---|---|---|---|---|
| Cm..... | 3 | 8 | 15 | 28 | 33 | 31 | 35 | 50 |

In seeking to determine the cause of this common biological feature, we may doubtless here disregard the relatively slight difference in average size between the two sexes, which will be referred to later on. The explanation would then seem to be, that fish of tardier growth exhibit year by year a constantly inferior increment to that of their more rapidly growing fellows.

A growth curve showing the annual increment for all the Faxe Bugt material presents, as will be seen, a fairly regular course, albeit the somewhat inadequate material in the case of the oldest groups (over VIII) doubtless renders the results here less reliable on the whole, and gives a slightly irregular increment as between the groups concerned. This is moreover due first and foremost to the wide range of variation among the oldest groups.

The table below shows the average length, compared with range of variation, within the

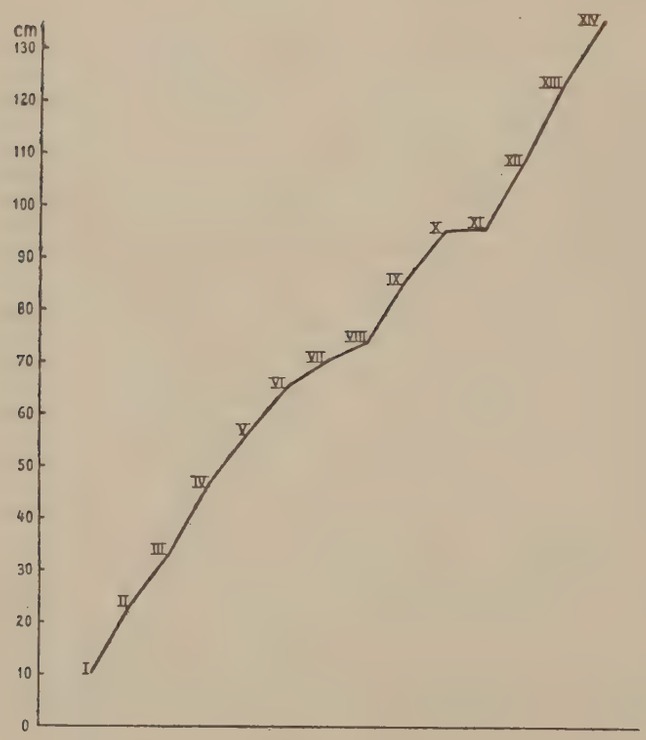



Fig. 2. — Growth Curve for Halibut from Faxe Bugt. I...XIV represents the age groups. June-July 1908, 1909.

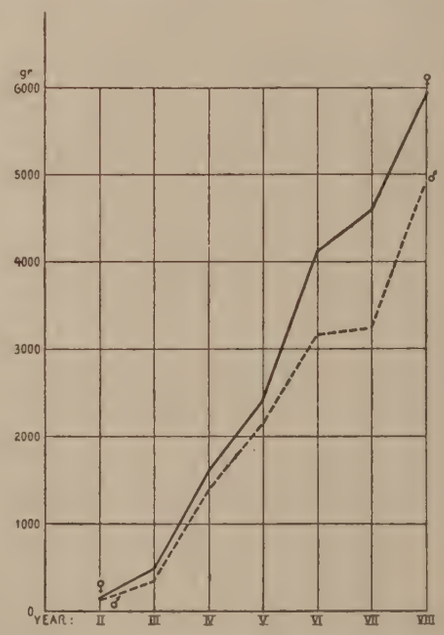



Fig. 3. — Graphical Chart showing weight of both sexes in Groups II—VIII. Halibut from Faxe Bugt. June-July 1908, 1909.

different groups for male and female respectively. The number of sex-determined specimens is about the same in both cases, the actual figures being 1009 ♂♂ and 993 ♀♀. From the results as shown, it might perhaps appear as if the ♂♂ did not reach so great an age as the ♀♀, though as a matter of fact they doubtless do. The apparent difference is due to the inadequacy of the material, as a comparison of the results from other Iceland localities, e. g. East Iceland, shows, that no such inequality exists. There seems then to be an essential difference in this respect between the halibut and the plaice (*Pleuronectes platessa*). In the latter, the ♂♂ do not appear to go beyond the VIII—IX groups, while the ♀♀, albeit but rarely, may attain an age of 20—30 years (see Maier 1906, Heincke 1916).

**Sizes of both sexes in the various age groups of halibut from Faxe Bugt. June—July 1908, 1909.**

| Age group | ♂ | | | ♀ | | | ♂ + ♀ | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of specimens | Average length cm. | Range of variation | No. of specimens | Average length cm. | Range of variation | No. of specimens | Average length cm. | Range of variation |
| I ..... | .. | .. | .. | .. | .. | .. | 36 | 10.1 | 8—15 |
| II ..... | 78 | 23.4 | 19—32 | 70 | 23.7 | 18—31 | 148 | 23.5 | 18—32 |
| III ..... | 784 | 32.5 | 22—47 | 685 | 33.9 | 21—48 | 1469 | 33.2 | 21—48 |
| IV ..... | 62 | 44.4 | 30—57 | 86 | 48.2 | 34—62 | 148 | 46.6 | 30—62 |
| V ..... | 14 | 56.0 | 46—63 | 43 | 56.8 | 41—71 | 57 | 56.6 | 41—71 |
| VI ..... | 17 | 62.2 | 57—70 | 32 | 66.9 | 53—87 | 49 | 65.3 | 53—87 |
| VII ..... | 22 | 66.7 | 58—76 | 40 | 72.0 | 55—104 | 62 | 70.1 | 55—104 |
| VIII ..... | 19 | 70.2 | 58—89 | 13 | 79.0 | 66—103 | 32 | 73.7 | 58—103 |
| IX ..... | 7 | 83.5 | 68—104 | 12 | 87.2 | 71—107 | 19 | 85.8 | 68—107 |
| X ..... | 4 | 95.5 | 75—113 | 5 | 95.2 | 77—141 | 9 | 95.3 | 75—141 |
| XI ..... | 2 | 83.0 | 79—87 | 2 | 108.5 | 97—120 | 4 | 95.7 | 79—120 |
| XII ..... | .. | .. | .. | 2 | 108.5 | 80—137 | 2 | 108.5 | 80—137 |
| XIII ..... | .. | .. | .. | 2 | 129.5 | 119—140 | 3 | 123.3 | 111—140 |
| XIV ..... | .. | .. | .. | 1 | 155.0 | .. | 2 | 135.5 | 116—155 |
| XV ..... | .. | .. | .. | .. | .. | .. | 1 | 110.0 | .. |

In accordance with what is known in the case of the plaice, we find also among halibut that the males are relatively smaller than the females of their year-class, as will be seen from the respective average lengths for the two sexes in the table above. The difference, however, is not very marked. On the other hand, we found, in the table of average weight per cm. length (p. 6) that a quite considerable increase was observable. And if we now glance at the average weights for each year class of males and females respec-

**Weight of both sexes in the various age groups of halibut from Faxe Bugt. June—July 1908, 1909.**

| Age group | ♂ | | | ♀ | | | ♂ + ♀ | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of specimens | Average weight gr. | Range of variation | No. of specimens | Average weight gr. | Range of variation | No. of specimens | Average weight gr. | Range of variation |
| I ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| II ..... | 28 | 121 | 70—370 | 12 | 145 | 80—260 | 40 | 130 | 70—370 |
| III ..... | 292 | 342 | 100—1200 | 238 | 470 | 120—1200 | 530 | 400 | 100—1200 |
| IV ..... | 17 | 1390 | 620—2400 | 28 | 1610 | 450—2500 | 45 | 1530 | 450—2500 |
| V ..... | 4 | 2150 | 750—2800 | 9 | 2410 | 1550—4100 | 13 | 2330 | 750—4100 |
| VI ..... | 5 | 3160 | 1900—4250 | 20 | 4123 | 1370—8800 | 25 | 3930 | 1370—8800 |
| VII ..... | 9 | 3230 | 2050—4900 | 14 | 4590 | 1800—9700 | 23 | 4050 | 1800—9700 |
| VIII ..... | 5 | 4860 | 2400—8000 | 8 | 5940 | 2520—7600 | 13 | 5520 | 2400—8000 |
| IX ..... | 1 | 7300 | .. | 1 | 5080 | .. | 2 | 6190 | 5080—7300 |
| X ..... | 2 | 10370 | 7700—13050 | 5 | 9080 | 5620—15600 | 7 | 9450 | 5620—15600 |
| XI ..... | .. | .. | .. | 1 | 14080 | .. | 1 | 14030 | .. |
| XII ..... | .. | .. | .. | 1 | 13400 | .. | 1 | 13400 | .. |

tively, it will be seen that the feature referred to is here far more distinctly apparent. The following table gives the figures concerned (p. 11).

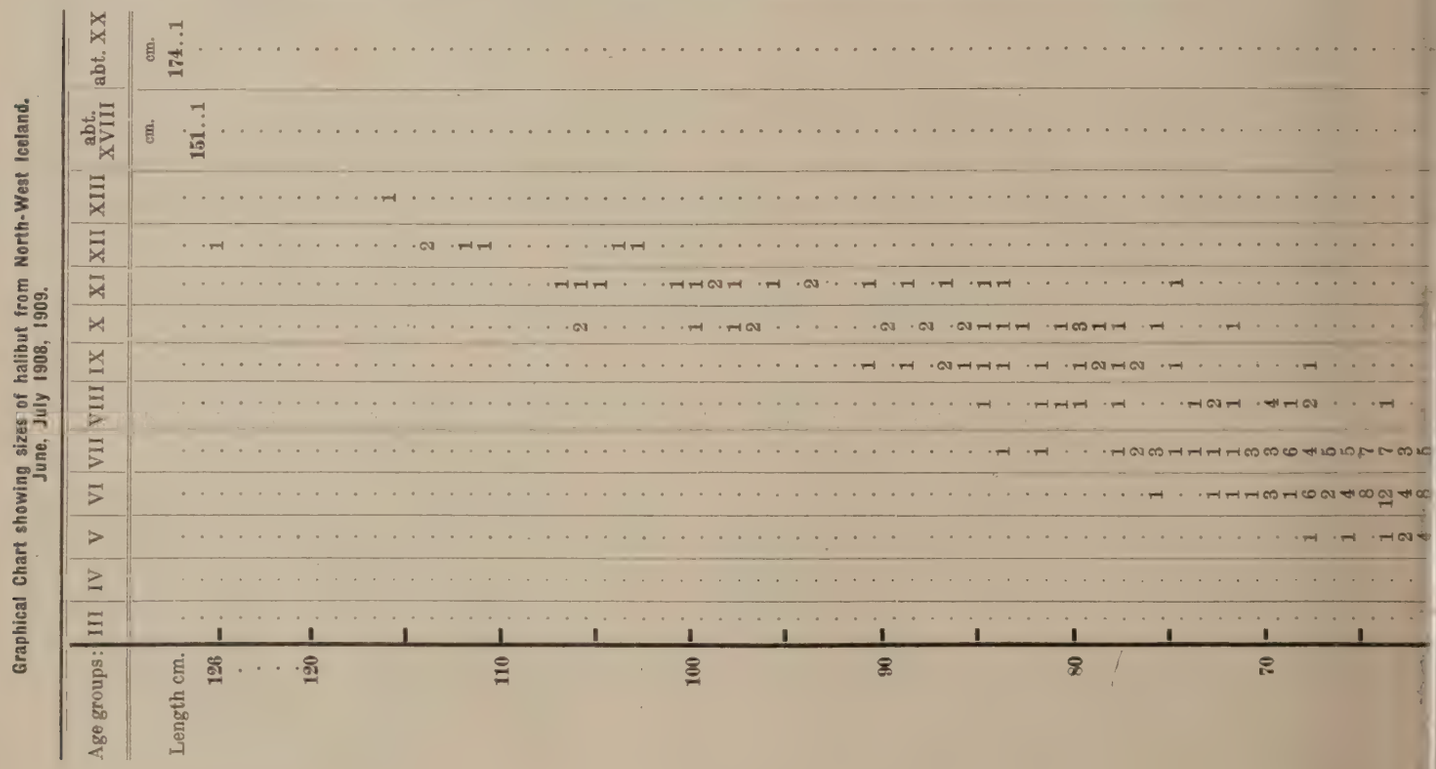
If we confine ourselves to consideration of such year groups as are represented by a fair amount of material (II—VIII) in a graphical chart as that given below, (vide p. 10) it will be noticed that the average weight of the females is constantly somewhat beyond that of the males in the same group. The difference between the weight of the two sexes is, naturally enough, found to increase more or less regularly with advancing age.

## 2. North-west Iceland.

In the fjords north of Faxe Bugt on the west coast of Iceland, a quantity of halibut were taken, partly on board the marine research steamer "Thor", and partly by the Icelandic trawler "Snorri Sturluson". From these hauls, a considerable number of otoliths were procured, representing in all 646 fish, from the following fjords or the waters at mouth of the same: Bredebugt, Patrexfjord, Arnefjord, Ønundarfjord, and Sugandafjord. There might perhaps be some ground for treating the material from these fjords separately, as the hydrographical conditions are hardly uniform for all. Such distinction would, however, here involve breaking up the material into quite small portions, hardly representative of the respective localities, and I have therefore preferred to treat the results from these waters under one head. A comparison of the figures from here with those for Faxe Bugt will make it clear that these two localities should be treated separately.

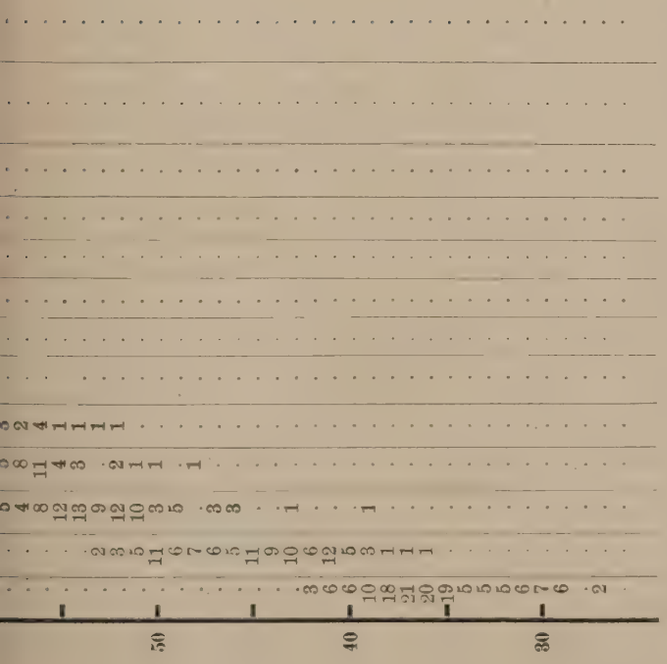
As seen from the general survey and graphical chart for average total lengths of the two sexes in each year-group, so also here we find a difference in size between the total lengths of the males and of the females in the respective groups.

This difference between the sexes will be found in all essentials to correspond entirely with what was noted in the case of the material from Faxe Bugt. A comparison between the average total lengths for each



**Sizes of various age groups. Halibut from North-West Iceland. June, July 1908, 1909.**

| Age group | ♂ | | | ♀ | | | ♂ + ♀ | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of specimens | Average length cm. | Range of variation cm. | No. of specimens | Average length cm. | Range of variation cm. | No. of specimens | Average length cm. | Range of variation cm. |
| I ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| II ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| III ..... | 69 | 35.6 | 27—42 | 70 | 35.7 | 29—42 | 139 | 35.7 | 27—42 |
| IV ..... | 57 | 44.8 | 36—51 | 45 | 46.0 | 37—53 | 102 | 45.4 | 36—53 |
| V ..... | 47 | 53.0 | 46—66 | 61 | 56.1 | 39—68 | 108 | 54.7 | 39—68 |
| VI ..... | 54 | 59.2 | 48—68 | 67 | 62.6 | 54—76 | 121 | 61.1 | 48—76 |
| VII ..... | 34 | 63.9 | 52—78 | 43 | 67.5 | 53—84 | 77 | 65.9 | 52—84 |
| VIII ..... | 5 | 68.6 | 64—70 | 12 | 75.3 | 68—85 | 17 | 73.3 | 64—85 |
| IX ..... | 11 | 81.1 | 68—91 | 5 | 80.2 | 75—87 | 16 | 81.5 | 68—91 |
| X ..... | 8 | 87.0 | 78—98 | 15 | 87.6 | 72—106 | 23 | 87.3 | 72—106 |
| XI ..... | 8 | 92.3 | 75—106 | 9 | 96.7 | 85—107 | 17 | 94.7 | 75—107 |
| XII ..... | 4 | 110.7 | 103—114 | 3 | 113.6 | 104—126 | 7 | 112.0 | 103—126 |
| XIII ..... | .. | .. | .. | 1 | 117.0 | .. | 1 | 117.0 | .. |
| XIV ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| XV ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| XVI ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| XVII ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| XVIII ..... | .. | .. | .. | 1 | 151.0 | .. | 1 | 151.0 | .. |
| XIX ..... | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| XX ..... | .. | .. | .. | 1 | 174.0 | .. | 1 | 174.0 | .. |



year group from Faxe Bugt and the fjords here treated reveals, however, the interesting feature that the halibut in the last-named waters attain a relatively smaller size than in Faxe Bugt, albeit the difference is not very marked, as will be seen from the following survey.

| ♂+♀ | III | IV | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|---|---|
| Faxe Bugt ..... | 33.2 | 46.6 | 56.6 | 65.3 | 70.1 | 73.7 | 85.8 | 95.3 | 95.7 |
| N.W.-Iceland .. | 35.7 | 45.4 | 54.7 | 61.1 | 65.9 | 73.3 | 81.5 | 87.3 | 94.7 |

We have unfortunately no material of the II group from Bredebugt and the remaining fjords of North-west Iceland, and are thus unable to determine whether this difference in the growth first makes itself apparent in the IV group. The average figures for the III group are, as we see, — despite the relatively large amount of material — the reverse of these for the remaining groups. As regards weight, the records from North-west Iceland include only a small number of specimens. On comparing the average weight per year-group with the corresponding values for Faxe Bugt, the above mentioned difference in the growth as between the different localities is extremely marked, as a glance at the following curves will show.

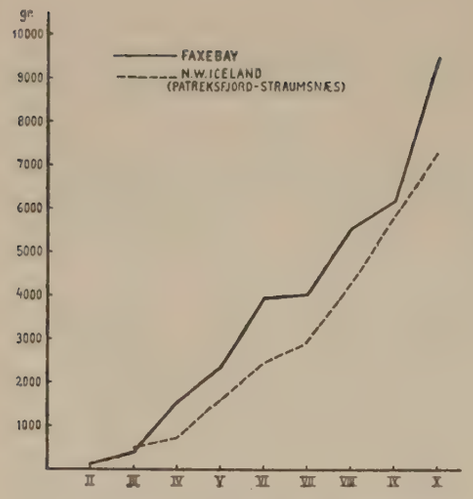


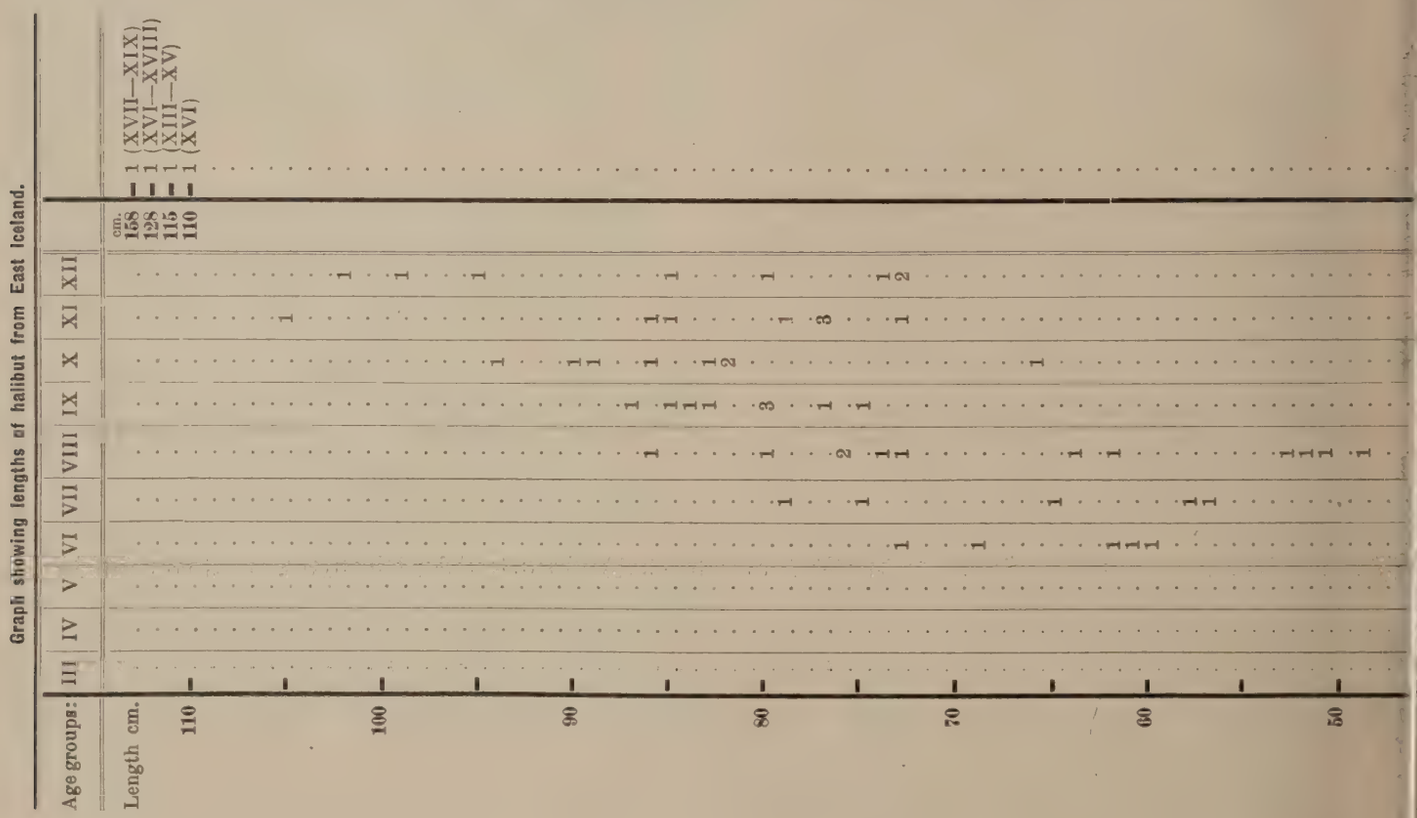

Fig. 4. — Graphical Chart showing average weights of various age groups of Halibut from Faxe Bugt and North-west Iceland.

**Weights of various age groups. Halibut from North-west Iceland.**

| Age group | ♂ | | | ♂ + ♀ | | | ♀ | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of specimens | Average weight gr. | Range of variation | No. of specimens | Average weight gr. | Range of variation | No. of specimens | Average weight gr. | Range of variation |
| I | . | . | . | . | . | . | . | . | . |
| II | . | . | . | . | . | . | . | . | . |
| III | . | . | . | 3 | 500 | 475—520 | 3 | 500 | 475—520 |
| IV | 3 | 830 | 775—820 | 3 | 570 | 550—590 | 6 | 700 | 550—820 |
| V | 3 | 1400 | 1100—1570 | 2 | 1800 | 1330—2270 | 5 | 1560 | 1100—2270 |
| VI | 6 | 2330 | 1780—3460 | 5 | 2500 | 1700—3420 | 11 | 2410 | 1700—3460 |
| VII | 6 | 2670 | 2390—3150 | 7 | 3100 | 2590—3820 | 13 | 2900 | 2390—3820 |
| VIII | 1 | 3260 | . | 2 | 4740 | 3760—5720 | 3 | 4240 | 3260—5720 |
| IX | 7 | 5890 | 4600—7750 | 1 | 5055 | . | 8 | 5790 | 4600—7750 |
| X | 3 | 7130 | 5120—8540 | 3 | 7420 | 5020—10650 | 6 | 7270 | 5020—10650 |
| XI | 2 | 6290 | 6170—6420 | 4 | 11760 | 9400—14850 | 6 | 9930 | 6170—14850 |
| XII | 1 | 17680 | . | 3 | 14550 | 12500—17760 | 4 | 15330 | 12500—17760 |
| XIII | . | . | . | 1 | 20110 | . | 1 | 20110 | |

## 3. East Iceland.

We have unfortunately only a small number of halibut otoliths from East Iceland, but even these are sufficient to show that there is a considerable difference between the growth of the halibut on the east coast and that of the fish from the west. We find that the growth in the former locality proceeds at a far slower rate than in the latter. It is regrettable that we have no information as to the weight of the



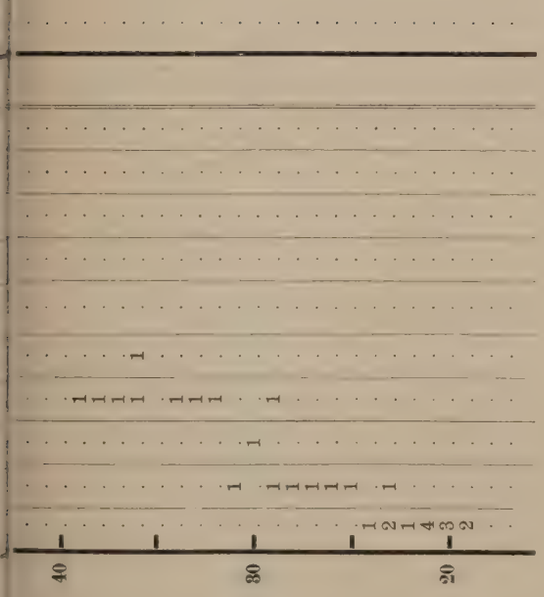
fish from these waters, as the weights would further — and doubtless even more distinctly — show the pronounced difference which exists between the halibut of East and West Iceland. The graphical chart likewise shows how remarkably slight the growth is here when compared with the localities previously mentioned. For the rest, reference may also be made to the following section.

**Sizes of various age groups. Halibut from East Iceland.**

| Age group: | ♂ | | | ♀ | | | ♂ + ♀ | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of specimens | Average length cm. | Range of variation | No. of specimens | Average length cm. | Range of variation | No of specimens | Average length cm. | Range of variation |
| I..... | .. | .. | .. | . | .. | .. | .. | .. | .. |
| II..... | .. | .. | .. | . | .. | .. | .. | .. | .. |
| III..... | 11 | 21.0 | 19—24 | 2 | 21.0 | 21 | 13 | 21.0 | 19—24 |
| IV..... | 4 | 26.0 | 23—29 | 3 | 28.3 | 26—31 | 7 | 27.0 | 23—31 |
| V..... | .. | .. | .. | 2 | 37.0 | 30—44 | 2 | 37.0 | 30—44 |
| VI..... | 7 | 47.4 | 29—73 | 7 | 45.2 | 32—69 | 14 | 46.3 | 29—73 |
| VII..... | 3 | 63.3 | 57—75 | 3 | 60.0 | 36—79 | 6 | 61.6 | 36—79 |
| VIII..... | 4 | 63.5 | 51—76 | 8 | 67.7 | 49—86 | 12 | 66.3 | 49—86 |
| IX..... | 8 | 80.5 | 75—85 | 1 | 87.0 | 87 | 9 | 81.2 | 75—87 |
| X..... | 6 | 85.8 | 82—94 | 2 | 78.5 | 66—91 | 8 | 84.0 | 66—94 |
| XI..... | 6 | 79.5 | 73—86 | 2 | 91.5 | 77—106 | 8 | 82.5 | 73—106 |
| XII..... | 4 | 85.2 | 73—99 | 4 | 85.2 | 73—103 | 8 | 85.2 | 73—103 |
| (XII—XV).... | 1 | 115.0 | .. | . | .. | .. | 1 | 115.0 | .. |
| XVI..... | 1 | 110.0 | .. | . | .. | .. | 1 | 110.0 | .. |
| (XVI—XVIII) | 1 | 128.0 | .. | . | .. | .. | 1 | 128.0 | .. |
| (XVII—XIX) . | .. | .. | .. | 1 | 158.0 | .. | 1 | 158.0 | . |

## 4. Growth in Iceland Waters generally.

The investigations as to growth of the halibut in the various fjords on the west and east coasts of Iceland have shown (p. 16).




**General survey of average lengths for halibut in the respective age groups at various localities in Iceland Waters.**

| Age group | S. W.-Iceland | | N. W.-Iceland | | E.-Iceland | |
|---|---|---|---|---|---|---|
| | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ |
| II ..... | 23.4 | 23.7 | .. | .. | .. | .. |
| III ..... | 32.5 | 33.9 | 35.6 | 35.7 | 21.0 | (21.0) |
| IV ..... | 44.4 | 48.2 | 44.8 | 46.0 | (26.0) | (28.3) |
| V ..... | 56.0 | 56.8 | 53.0 | 56.1 | .. | (37.0) |
| VI ..... | 62.2 | 66.9 | 59.2 | 62.6 | 47.4 | 45.2 |
| VII ..... | 66.7 | 72.0 | 63.9 | 67.5 | (63.3) | (60.0) |
| VIII ..... | 70.2 | 79.0 | 68.6 | 75.3 | (63.5) | 67.7 |
| IX ..... | 83.5 | 87.2 | 81.1 | 80.2 | 80.5 | (87.0) |
| X ..... | (95.5) | 95.2 | 87.0 | 87.6 | 85.8 | (78.5) |
| XI ..... | (83.0) | (108.5) | 92.3 | 96.7 | 79.5 | (91.5) |
| XII ..... | .. | (108.5) | (110.7) | (113.6) | (85.2) | (85.2) |
| XIII ..... | .. | (129.5) | .. | (117.0) | .. | .. |
| XIV ..... | .. | (155.0) | .. | .. | (115.0) | .. |
| XV ..... | .. | .. | .. | .. | .. | .. |
| XVI ..... | .. | .. | .. | .. | (110.0) | .. |
| XVII ..... | .. | .. | .. | .. | (128.0) | .. |
| XVIII ..... | .. | .. | .. | (151.0) | .. | (158.0) |
| XIX ..... | .. | .. | .. | .. | .. | .. |
| XX ..... | .. | .. | .. | (174.0) | .. | .. |

1. That there is a considerable difference in the growth of the halibut in the different fjords, presumably due chiefly to differences of temperature, and

2. That the females on an average attain a greater weight and length than the males of their respective year groups.

This last-mentioned point has previously been treated, especially in the case of Faxe Bugt, and in the other localities also there appears to be a somewhat similar relation between the growth of the two sexes. It will here suffice to note the sizes for all the different localities as illustrative of the difference in rate of growth.

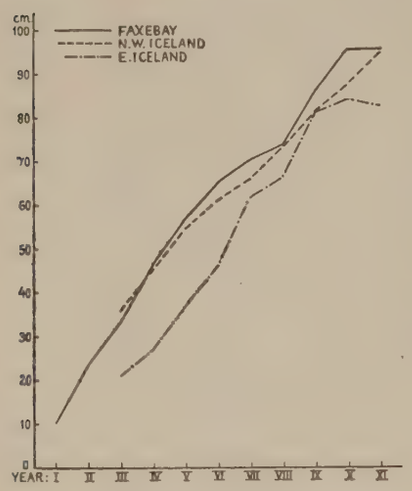



Fig. 5. — Growth Curves for Halibut from Faxe Bugt, N. W.-Iceland and E.-Iceland.

The above survey (p. 15) serves to give an idea as to the average lengths of males and females in the different year-groups at the three localities: South-west Iceland, North-west Iceland and East Iceland. A more concise wiev of the average lengths will be seen below, together with a graphical illustration of the average growth curves for these localities.

**Average total length in cm. of Iceland halibut.**

| ♂ + ♀ | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Faxe Bugt..... | 23.7 | 33.2 | 46.6 | 56.6 | 65.3 | 70.1 | 73.7 | 85.8 | 95.3 | (95.7) | (108.5) |
| N.W.-Iceland ... | ... | 35.7 | 45.4 | 54.7 | 61.1 | 65.9 | 73.3 | 81.5 | 87.3 | 94.7 | 112.0 |
| East-Iceland .... | ... | 21.0 | 27.0 | (37.0) | 46.3 | 61.6 | 66.3 | 81.2 | 84.0 | 82.5 | 85.2 |

It will be seen from the above, that the halibut find most favourable conditions in Faxe Bugt, and the least favourable in East Iceland. We have unfortunately no material from South Iceland, and can say nothing as to what may be the conditions there prevailing, but there can hardly be any doubt that the conditions affecting growth deteriorate from Faxe Bugt and northward round the coast to East Iceland. These conditions are then doubtless entirely dependent upon the hydrographical features of the different localities, of which temperature will presumably be the most important. The hydrographical conditions in Faxe Bugt and on the East coasts of Iceland are, as we know, widely different, and in accordance with these differences we find, that a halibut of given length from Seydisfjord will on an average be 2 to 3 years older than one of the same length from Faxe Bugt.

# IV. The Halibut Fishery of Iceland and the Færoes.

A general description of the halibut fishery will be found, in Johs. Schmidt: Fiskeriundersøgelser ved Island og Færøerne i Sommeren 1903, and it will therefore not be necessary here to give a detailed account. The following pages will accordingly be devoted mainly to statistics concerning the yield of the fishery in recent years, based on the various Fishery Reports, and the statistical material from Scotland previously mentioned.

## 1. Iceland.

In dealing with the halibut fishery of Iceland, it is necessary first of all to distinguish between the two methods employed in the industry. The branch more especially directed towards the capture of halibut

is the long line fishery, and this is accordingly of greater importance in economical respects. Far less important from this point of view is the trawl fishery for halibut, though this also is by no means insignificant. With the halibut, as with most other economically important fish in Iceland waters, only an extremely small percentage of the yield falls to the natives, the rich stock of halibut found on these grounds being exploited first and foremost by foreign vessels.

### A. The native industry.

The halibut has always formed an prominent item in the Icelander's menu, and no small quantities of these fish are taken for private consumption; as an article of export, on the other hand the halibut has never been of any importance.

The fishery is carried out exclusively with lines, either cod lines and lines with halibut hooks, or hand lines. No exhaustive statistics are available as to the yield, but the information given in the annual reports, "Landshagsskýrslur fyrir Ísland" may nevertheless doubtless be taken as giving a fair idea of the amount represented. The records in these rapports give the number of halibut caught. In the following table, these figures have been worked out so as to show the weight taken, (reckoning the average as 9 kg. per fish) in accordance with the method followed by the statistical reports of the International Marine Investigations ("Bulletin statistique des pêches maritimes des pays du nord de l'Europe")[1].

| | | | |
|---|---|---|---|
| 1897 | 144,000 kg. | 1905 | 361,440 kg. |
| 1898 | 153,000 — | 1906 | 299,250 — |
| 1899 | 198,000 — | 1907 | 375,030 — |
| 1900 | 229,500 — | 1908 | 253,350 — |
| 1901 | 301,500 — | 1909 | 172,800 — |
| 1902 | 273,000 — | 1910 | 132,300 — |
| 1903 | 216,000 — | 1911 | 233,190 — |
| 1904 | 272.700 — | | |

### B. Foreign Fishery in Iceland Waters.

Among the foreign nations carrying on halibut fishery in Iceland waters, England ranks incontestably first, accounting as a rule for well over twice the amount taken by all other nations together. The countries participating in this fishery are as follows: England, Scotland, Germany, Holland and Belgium. For 1906—1910, the yield falling to each is, according to the Bulletin Statistique, as follows: (weight in kilos)

| | England | Scotland | Germany | Nether-lands | Bel-gium | Total Quantity |
|---|---|---|---|---|---|---|
| 1906 ... | 4,983,023 | 45,720 | 83,734 | 9,495 | 3,788 | 5,125,760 |
| 1907 ... | 7,219,188 | 100,178 | 185,052 | 10,093 | 1,322 | 7,515,833 |
| 1908 ... | 6,939,026 | 75,082 | 268,269 | 13,774 | 6,211 | 7,302,362 |
| 1909 ... | 5,444,744 | 41,250 | 306,813 | 20,487 | 19,566 | 5,832,860 |
| 1910 ... | 4,631,741 | 927,933 | 418,986 | 25,514 | 10,916 | 6,015,090 |

On adding up the proceeds for these five years, we obtain a total yield for each of the five countries as follows:

| | |
|---|---|
| England ..... | 29,217,722 kg. |
| Scotland ..... | 1,190,163 — |
| Germany ..... | 1,262,854 — |
| Netherlands ..... | 79,363 — |
| Belgium ..... | 41,803 — |

The graphical illustration of the share falling to the various participating countries shows how markedly predominant a position England occupies in comparison with the rest. The international statistical reports are, unfortunately, only available up to 1910, so that we cannot pursue the comparison beyond that date. As it happens, however, English statistics for this fishery have been issued up to 1914, and in view of the great importance of that country's interest

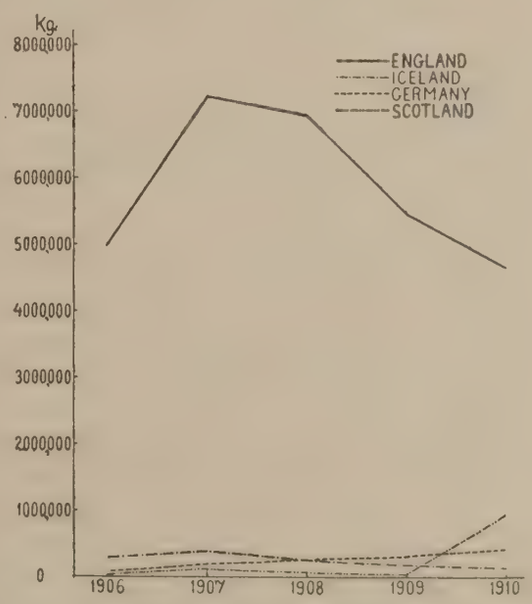



Fig. 6. — Graphical Chart showing Halibut Fishery of various nations in Iceland waters 1906—1910.

[1] In the Report for 1908, the yield of halibut for Iceland is erroneously stated as 2,533,500 kilos instead of 253,350 kilos.

in the Iceland halibut fishery it may be interesting to study the records in question further. The English halibut fishery is carried on partly by trawlers and partly with long lines, laid out from steamers specially equipped for the purpose. In the English Fishery Reports, these two methods are separately dealt with, and it is well worth while to note the difference in fishing capacity which the figures show.

The next table shows the annual yield in kilos for trawlers and line steamers respectively; also the percentage of halibut taken by British vessels in Iceland waters (for the Færoes *vide infra*) as compared with other grounds; also the proportional percentage of the halibut yield compared with the total catch of demersal fish. Finally, the daily haul for trawlers and liners is likewise noted. The figures for 1914 are shown in parentheses, as it is not impossible that the outbreak of war in August of that year may in part account for the comparative smallness of the yield.

**English Halibut Fishery in Iceland waters 1906—1914.**

| | Trawlers | Liners | Total | Percentage taken in each region | Proportion per cent of Halibut to Quantity of demersal Fish | Average catch per day's absence | |
|---|---|---|---|---|---|---|---|
| | | | | | | Trawlers | Liners |
| | kg. | kg. | kg. | % | | kg. | kg. |
| 1906 ..... | 1,087,628 | 3,895,395 | 4,983,023 | 60.26 | 5.90 | 30.99 | 517.65 |
| 1907 ..... | 1,303,172 | 5,916,016 | 7,219,188 | 68.26 | 8.51 | 38.61 | 647.19 |
| 1908 ..... | 1,402,131 | 5,536,895 | 6,939,026 | 69.19 | 7.88 | 43.69 | 505.97 |
| 1909 ..... | 1,298,143 | 4,146,601 | 5,444,744 | 65.99 | 7.86 | 47.75 | 392.18 |
| 1910 ..... | 1,440,282 | 3,191,459 | 4,631,741 | 66.14 | 6.17 | 48.77 | 322.07 |
| 1911 ..... | 1,190,092 | 3,641,039 | 4,831,131 | 69.54 | 5.79 | 39.11 | 321.06 |
| 1912 ..... | 1,220,317 | 2,870,048 | 4,090,365 | 69.11 | 5.03 | 39.62 | 279.40 |
| 1913 ..... | 1,140,511 | 2,359,609 | 3,500,120 | 66.08 | 3.69 | 30.99 | 261.11 |
| (1914 ..... | 1,060,094 | 1,589,278 | 2,649,372 | 65.90 | 2.60 | 27.43 | 195.58) |

The fishery for this period is further illustrated by the accompanying graphical charts.

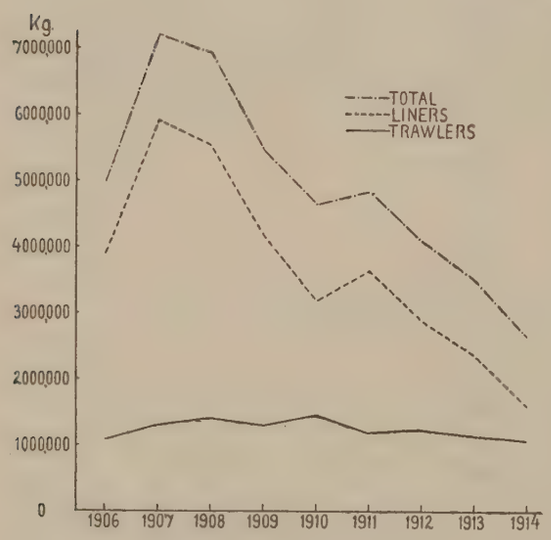



Fig. 7. — Graphical Chart showing yield of English Halibut Fishery in Iceland waters 1906—1914.

From the above it will be seen how greatly the total annual yield has fallen off during the period in question, even disregarding the low figures for 1914. In the course of six years, from 1907—8 to 1913—14, the total yield has as a matter of fact dwindled practically to half, i. e. from abt. 7 million kilos to abt. 3.5 million. Further investigation reveals the interesting fact that it is essentially the catch made by the line steamers which has undergone reduction. The yield of the trawlers has remained more or less constant throughout the whole time. This might, of course be supposed to be due to a decrease in the number of line steamers working the grounds, which would naturally give a smaller yield. There is always the possibility that something of this kind may have taken place, and the figures should not therefore be considered as of supreme importance, There is, however, another point which gives us a more correct idea of the state of things, to wit, a comparison of the average catch per day's absence during the different years. Albeit the outbreak of war in 1914 may

have affected the total yield for that year, it is hardly likely that the same fact should have influenced — at any rate in a marked degree — the average catch per day's absence.

The following chart shows as a matter of fact precisely the same picture, in a corresponding manner, as that of the total catch.

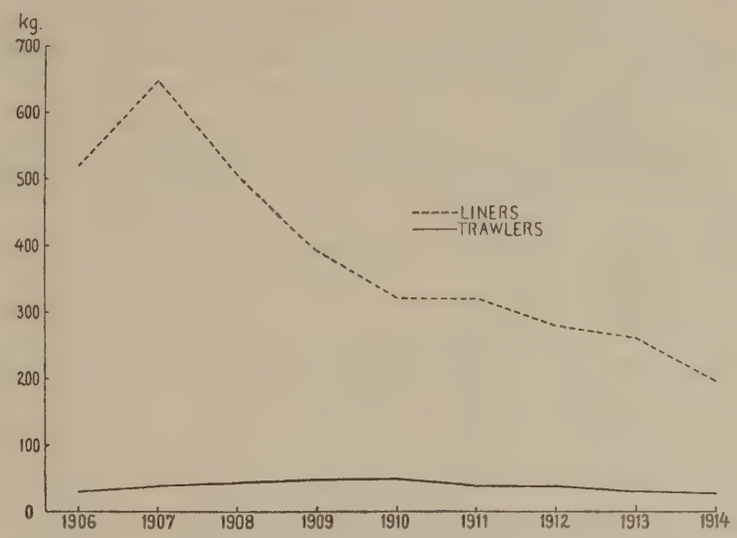



Fig. 8. — Average catch per day's absence. English Halibut fishery in Iceland waters 1906—1914.

The English halibut fishery in Iceland waters thus shows a more or less gradual decline of the total yield from the year 1907 to 1913. It will in this connection be of interest to consider the Scottish halibut fishery in the same waters in like manner. The investigations are here chiefly based upon the material procured as to the fishery of Aberdeen trawlers and liners in Iceland waters.

The material here received from Scotland as regards the halibut fishery includes specified statements for both liners and trawlers from Aberdeen. In the case of the line fishery, the number of trips from Aberdeen is noted, together with the number of lines employed during the different months of the years 1908—15. The mean values for these are:

**Aberdeen Liners. Iceland.**

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of Trips | 5.0 | 4.5 | 4.0 | 2.0 | 3.7 | 3.5 | 4.4 | 4.0 | 3.6 | 4.2 | 5.0 | 4.5 | 4.0 |
| No. of Lines | 529 | 467 | 535 | 220 | 524 | 556 | 805 | 848 | 627 | 600 | 655 | 474 | 570 |

The average monthly yield for the various years is in the present material stated in cwts. per 100 lines fishing.

**Average monthly yield of halibut in ctws. per 100 lines fishing for Aberdeen Liners, Iceland 1908—1915.**

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1908..... | .. | .. | .. | .. | 65.3 | .. | .. | .. | .. | .. | .. | .. | . |
| 1909..... | .. | .. | 33.3 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| 1910..... | . | .. | .. | .. | .. | .. | .. | .. | .. | .. | 18.8 | 19.3 | .. |
| 1911..... | .. | .. | .. | .. | 68.9 | 82.6 | 64.0 | 70.8 | 51.7 | 16.0 | .. | 5.3 | .. |
| 1912..... | .. | .. | .. | 40.2 | 64.6 | 65·8 | 66.4 | 64.0 | 75.8 | 39.5 | 8.6 | 3.5 | .. |
| 1913..... | 23.3 | 18.0 | 52.5 | .. | 42.4 | 59.6 | 77.0 | 62.0 | 74.5 | .. | 6.7 | 3.7 | |
| 1914..... | 22.5 | .. | .. | .. | 24.9 | 60.8 | 60.8 | 39.2 | 47.4 | 13.5 | 4.0 | 7.8 | .. |
| 1915..... | 5.7 | 17.2 | 10.8 | 25.6 | 30.6 | 46.8 | 30.9 | 13.1 | 17.6 | 8.4 | 3.4 | 11.6 | 18.5 |
| Mean ... | 17.2 | 17.6 | 32.2 | 32.9 | 49.4 | 63.1 | 59.8 | 49.8 | 53.4 | 19.4 | 8.3 | 8.5 | 34.3 |

A comparison of the yield for the different years shows an apparent decline during the latter part of the period. The graphical chart (Fig. 9), giving the mean values for 1911—12 and 1914—15, will sufficiently illustrate this.

If we now proceed to consider the yield of the trawlers per 100 hours' fishing in like manner, we find the monthly yield for the different years as follows below.

The average monthly yield for the years 1910—12 and 1913—15 is shown in the accompanying curves (Fig. 10), from which it will be seen that there is no ap-

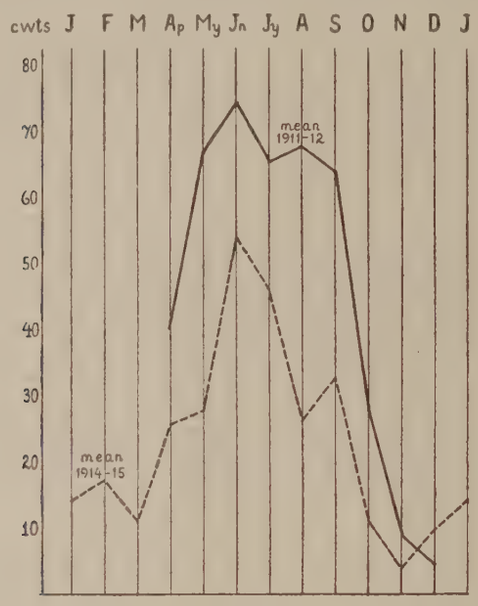



Fig. 9. Graph showing average monthly yield of halibut in cwts. per 100 lines fishing for the years 1911—12 and 1914—1915. Aberdeen Liners. Iceland.

Fig. 10. Graph showing average monthly yield of halibut in cwts. per 100 hours fishing, 1910—1912 and 1913—15. Aberdeen Trawlers. Iceland.

**Average monthly yield of halibut in ctws. per 100 hours fishing for Aberdeen trawlers, Iceland 1904—1915.**

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Annual Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1904..... | 16.7 | .. | .. | 4.7 | 13.2 | 12.7 | 12.0 | 24.2 | 29.2 | 35.0 | .. | .. | .. |
| 1905..... | .. | 11.8 | 12.1 | 9.2 | 5.4 | 5.6 | 4.6 | 6.4 | 22.9 | 36.7 | .. | .. | .. |
| 1906..... | 5.0 | 1.1 | 2.5 | 5.0 | 4.0 | 6.4 | 7.8 | 10.1 | 8.8 | 2.9 | 0.9 | 5.5 | 5.0 |
| 1907.. .. | 1.1 | 1.2 | 1.3 | 3.1 | 7.0 | 12.1 | 4.9 | 6.1 | 6.2 | 6.6 | 5.2 | 1.4 | 4.7 |
| 1908..... | 0.8 | 1.8 | 1.9 | 4.1 | 5.5 | 4.7 | 5.6 | 5.5 | 9.6 | 7.3 | .. | 2.8 | .. |
| 1909..... | 3.3 | 2.8 | 5.2 | 4.7 | 2.4 | 6.5 | 7.3 | 9.1 | 4.7 | 3.3 | .. | 9.2 | .. |
| 1910..... | 3.4 | 5.8 | 3.5 | 3.0 | 4.4 | 8.2 | 5.5 | 8.0 | 10.7 | 13.7 | 15.1 | 7.2 | 6.5 |
| 1911..... | 7.2 | 4.6 | 4.9 | 5.1 | 7.4 | 9.8 | 7.8 | 8.5 | 9.3 | 24.2 | 20.5 | 8.0 | 9.8 |
| 1912..... | 5.7 | 4.4 | 2.2 | 4.1 | 8.3 | 8.1 | 5.7 | 4.9 | 4.5 | 8.1 | 11.4 | 6.3 | 6.1 |
| 1913..... | 7.1 | 2.3 | 2.3 | 1.7 | 5.1 | 7.8 | 5.7 | 4.4 | 5.5 | 5.6 | 4.6 | 2.5 | 4.6 |
| 1914..... | 2.0 | 1.8 | 1.0 | 1.5 | 3.2 | 7.4 | 5.0 | 6.3 | 11.8 | 9.8 | 17.1 | 24.0 | 7.6 |
| 1915..... | 12.2 | 4.6 | 10.2 | 7.7 | 10.4 | 16.0 | 11.8 | 13.1 | 15.1 | 28.8 | 4.2 | 40.6 | 14.6 |
| Mean ... | 5.9 | 3.8 | 4.3 | 4.5 | 6.4 | 8.8 | 7.0 | 8.9 | 10.7 | 15.2 | 9.9 | 10.8 | 8.0 |

parent difference in the results. It is nevertheless worth while to note the relatively large yield for 1915, indicated by the above, this at any rate does not seem to suggest that any decline should have taken place of late years.

It is interesting to glance at the results of the fishery as noted for the various months. The average monthly number of trips and of fishing hours will be seen from the table below, giving the mean values for the years 1904—15.

**Aberdeen Trawlers. Iceland.**

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Ann. Mean. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of Trips. | 13.1 | 16.5 | 29.5 | 52.0 | 52.4 | 33.3 | 18 3 | 17.5 | 10.1 | 4.8 | 5.8 | 13.1 | 22.2 |
| No. of Hours. | 1327 | 1644 | 2214 | 3517 | 4469 | 3479 | 2618 | 2293 | 1410 | 657 | 737 | 1370 | 2145 |

From this it will be seen, that the fishery of the Aberdeen trawlers in Iceland waters is at its height during the months of April—June.

The outbreak of war in 1914 has, it need hardly be said, strongly affected the work of the Scottish trawlers in Iceland waters. The number of trips to Iceland was during the years 1910—1915 as follows:

| | | |
|---|---|---|
| 1910..... | 289 | Trips. |
| 1911..... | 318 | — |
| 1912..... | 399 | — |
| 1913..... | 479 | — |
| 1914..... | 449 | — |
| 1915..... | 96 | — |

The effect of the war is even more distinctly evident when we compare the number of trips in 1914—15 August to July inclusive, with that for the previous year 1913—14 similarly reckoned. The number of trips to Iceland made by Aberdeen trawlers in these years was 80 and 568 respectively. Such a falling off must necessarily involve a considerable decrease in the total yield of the trawl fishery.

Summing up the various results on the basis of the present material, regarding the Scottish halibut fishery in Iceland waters, we obtain the impression that there has of late years been a considerable decrease in the yield of the line fishery, whereas the trawling industry has more or less maintained the same level as before. These results thus agree in the main with those noted for the English Halibut fishery in the same waters.

---

Since we thus find that a decrease has actually taken place in the total yield of the Halibut fishery in Iceland waters during late years, the question naturally arises, what are the conditions which have brought about this reduction of the yield.

The following points suggest themselves as possible explanation of the fact in question:

1. Decrease due to temporary fluctuation.
2. Decrease due to transference of craft to other economically important branches of the fishing industry, e. g. the cod fishery.
3. Decrease due to a reduction in the stock of halibut owing to overfishing.

These points will now be further considered.

1. The suggestion as to decrease due to temporary fluctuation can neither be proved nor disproved from the material available.

2. There is one thing which seems to indicate that the decrease in the yield might possibly be due to certain alterations in the industry. This should in particular apply to the line fishery, where, as we have seen, the decrease is far more pronounced than elsewhere; it could for instance be supposed that a number of these line steamers had of late years gone over to cod fishing instead of halibut. This might involve a movement to other fishing grounds, where the yield of halibut is only minimal. This theory is especially

supported by the following extract from a communication dated 31. Oct. 1916 from Mr. Walter Duff, Aberdeen, to the Secretary, Fishery Board for Scotland (Mr. D. T. Jones) Edinburgh. "From landings of Grimsby vessels at Aberdeen it may be inferred that in recent years, English vessels have been engaged more in cod fishing than in quest for halibut. In 1914 for instance, 16,774 cwts. of cod, in the total of 21,245 cwts., were landed in October, November and December. Further, every endeavour is made to supply as much squid as possible for bait, as the squid is reckoned to be the best bait for cod, at the season. The grounds then frequented on the

**Trawling hauls of Halibut in Faxe Bugt. S/S "Snorri Sturluson".**

| | | | | | Average no. per hour | Average weight per hour |
|---|---|---|---|---|---|---|
| I | 9.—10. June 1908 | 16 Hours Trawling: | 428 spec. | = 184,9 kg | 27 spec. | 11.5 kg |
| II | 5.—6. July 1908 | $5^1/_2$ - — | 33 - | = 74,7 - | 6 — | 13.5 - |
| III | 6.—7. July 1908 | 8 - — | 73 - | = 67,6 - | 9 — | 8.5 - |
| IV | June—July 1909 | 79 - — | 1724 - | = 999 - | 22 — | 12.6 - |

**Trawling hauls of halibut from Faxe Bugt. 10 June 1908. S/S "Snorri Sturluson".**

| Age group | ♂ | | | | | | | | | ♀ | | | | | | | | | ♂ + ♀ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | II | III | IV | V | VI | VII | VIII | IX | Total | II | III | IV | V | VI | VII | VIII | IX | Total | II | III | IV | V | VI | VII | VIII | IX | Total |
| 20 cm. .... | 1 | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | . | 1 |
| | 2 | . | . | . | . | . | . | . | 2 | 4 | . | . | . | . | . | . | . | 4 | 6 | . | . | . | . | . | . | . | 6 |
| | 2 | . | . | . | . | . | . | . | 2 | 1 | . | . | . | . | . | . | . | 1 | 3 | . | . | . | . | . | . | . | 3 |
| | 5 | . | . | . | . | . | . | . | 5 | 2 | . | . | . | . | . | . | . | 2 | 7 | . | . | . | . | . | . | . | 7 |
| | 4 | 1 | . | . | . | . | . | . | 5 | . | 1 | . | . | . | . | . | . | 1 | 4 | 2 | . | . | . | . | . | . | 6 |
| 25 — .... | 2 | . | . | . | . | . | . | . | 2 | . | 2 | . | . | . | . | . | . | 2 | 2 | 2 | . | . | . | . | . | . | 4 |
| | 1 | 2 | . | . | . | . | . | . | 3 | 1 | 1 | . | . | . | . | . | . | 2 | 2 | 3 | . | . | . | . | . | . | 5 |
| | . | 10 | . | . | . | . | . | . | 10 | . | 4 | . | . | . | . | . | . | 4 | . | 14 | . | . | . | . | . | . | 14 |
| | 1 | 23 | . | . | . | . | . | . | 24 | . | 9 | . | . | . | . | . | . | 9 | 1 | 32 | . | . | . | . | . | . | 33 |
| | . | 11 | . | . | . | . | . | . | 11 | . | 11 | . | . | . | . | . | . | 11 | . | 22 | . | . | . | . | . | . | 22 |
| 30 — .... | . | 41 | . | . | . | . | . | . | 41 | . | 22 | . | . | . | . | . | . | 22 | . | 63 | . | . | . | . | . | . | 63 |
| | . | 28 | . | . | . | . | . | . | 28 | . | 18 | . | . | . | . | . | . | 18 | . | 46 | . | . | . | . | . | . | 46 |
| | . | 23 | . | . | . | . | . | . | 23 | . | 12 | . | . | . | . | . | . | 12 | . | 35 | . | . | . | . | . | . | 35 |
| | . | 26 | . | . | . | . | . | . | 26 | . | 8 | . | . | . | . | . | . | 8 | . | 34 | . | . | . | . | . | . | 34 |
| | . | 2 | . | . | . | . | . | . | 2 | . | 6 | 1 | . | . | . | . | . | 7 | . | 8 | 1 | . | . | . | . | . | 9 |
| 35 — .... | . | 11 | . | . | . | . | . | . | 11 | . | 9 | . | . | . | . | . | . | 9 | . | 20 | . | . | . | . | . | . | 20 |
| | . | 8 | . | . | . | . | . | . | 8 | . | 8 | . | . | . | . | . | . | 8 | . | 16 | . | . | . | . | . | . | 16 |
| | . | 6 | . | . | . | . | . | . | 6 | . | 5 | . | . | . | . | . | . | 5 | . | 11 | . | . | . | . | . | . | 11 |
| | . | 3 | . | . | . | . | . | . | 3 | . | 8 | . | . | . | . | . | . | 8 | . | 11 | . | . | . | . | . | . | 11 |
| | . | 2 | . | . | . | . | . | . | 2 | . | 7 | . | . | . | . | . | . | 7 | . | 9 | . | . | . | . | . | . | 9 |
| 40 — .... | . | 2 | . | . | . | . | . | . | 2 | . | 2 | 1 | . | . | . | . | . | 3 | . | 4 | 1 | . | . | . | . | . | 5 |
| | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | 1 | . | 1 | . | . | . | . | . | . | 1 |
| | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | 1 | . | 1 | . | . | . | . | . | . | 1 |
| | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | 1 | . | 1 | . | . | . | . | . | . | 1 |
| 45 — .... | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 50 — .... | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | 1 | . | . | 1 | . | . | . | . | . | 1 |
| | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | 1 | . | . | 1 | . | . | . | . | . | 1 |
| | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 55 — .... | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| 88 — .... | . | . | . | . | . | . | . | 1 | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 1 |

Trawling hauls of halibut in Faxe Bugt. June, July 1909. S/S „Snorri Sturluson".

| cm. | |
|---|---|
| 104 | 1 |
| 77 | 1 |
| 70 | 2 |
| | 1 |
| | 2 |
| 65 | 1 |
| | 5 |
| | 1 |
| | 2 |
| 60 | 2 |
| | 1 |
| | 2 |
| | 3 |
| | 2 |
| 55 | 5 |
| | 8 |
| | 8 |
| | 6 |
| | 9 |
| 50 | 7 |
| | 22 |
| | 25 |
| | 27 |
| | 52 |
| 45 | 54 |
| | 62 |
| | 62 |
| | 64 |
| | 72 |
| 40 | 69 |
| | 74 |
| | 72 |
| | 64 |
| | 77 |
| 35 | 64 |
| | 63 |
| | 47 |
| | 55 |
| | 50 |
| 30 | 48 |
| | 62 |
| | 67 |
| | 77 |
| | 92 |
| 25 | 86 |
| | 60 |
| | 40 |
| | 21 |
| | 14 |
| 20 | 7 |
| | 3 |
| | 3 |
| 15 | |

east side of Iceland (off Seidis Fjord, Havilsbak and Easter Horn) yielded heavy shots of cod, but very few halibut."

There is thus much to support the view that the decrease in the yield is due to the partial transference of the fishery during late years to grounds where there is a better chance of obtaining good hauls of cod.

3. The question as to whether the intensive fishery which has for years been carried on in Iceland waters after halibut may possibly be one cause of the decline in the yield of late is one which it would be most desirable to have answered. The point will therefore be subjected to closer enquiry.

As already mentioned, the hauls made with the implements used in modern trawling include great numbers of quite young halibut, and it is therefore more or less natural to seek an explanation of the decreasing yield in reduction of the stock on the grounds.

On the south-west coast of Iceland, great numbers of young halibut are found in Faxe Bugt, and as an intensive trawl fishery is carried on in this very locality, the young fish are here destroyed on a large scale. The following typical examples of trawling hauls made in Faxe Bugt will serve to give an idea as to the inroads made by the great number of trawlers on the stock of halibut (*vide* p. 22).

It will be seen that each trawler takes on an average abt. 16 halibut with a total weight of 11.5 kilos per hour. The average weight per fish for these four hauls is 0.43, 2.26, 0.92 and 0.57 kilos respectively, which is enough to show that the fish taken by this method are mostly small. The survey above of a typical trawl catch from Faxe Bugt will make clear what age groups are chiefly taken in the trawl, and the distribution of the two sexes in the material (*vide* p. 22).

A further illustration of the fact that the smaller sizes of halibut are incontestably taken mainly by the trawl will be gained from the table on this page showing the capture of 1724 halibut from trawl fishery, (S/S "Snorri Sturluson") in Faxe Bugt in June—July 1909, comprising in all 79 hours fishing.

Considering the large number of trawlers which under normal conditions ply their trade in Faxe Bugt, and reckoning the catch of each to average 16 halibut = 11 kilos weight per trawling hour, it will readily be understood that the quantity of young halibut annually destroyed by the trawl fishery is by no means inconsiderable. Most of these fish are from 2—3 years old, and when we rememher that the halibut rarely attain maturity before their ninth or tenth year at the earliest, (*vide infra*, under propagation, p. 30) it does not seem impossible that such destruction of immature specimens can in the long run exert a detrimental effect upon the maintenance of the stock. And it need hardly be said that wholesale destruction of young fish is doubly fatal in the case of halibut, with their slow growth and late maturity.

The present material does not in itself suffice to determine which of the three factors here mentioned is responsible for the marked decrease in the yield of the halibut fishery of late years. The two first named explanations will hardly claim any particular attention; the last however, strongly demands consideration. An exhaustive statistical material would be required for its further discussion, and it will here, *inter alia* be of the highest importance to introduce a system of classification in the halibut statistics, which would render them far more valuable than hitherto. If then it is found, on continued investigation, that the evident decline in the yield is chiefly due to intensive fishery among the young fish, international regulations should be resorted to, concerning the capture of halibut in Iceland waters, with a view to the maintenance of the stock.

First of all, however, a closer investigation of the cause of the decline in the yield is absolutely necessary; this once established, is will then be time, if necessary, to discuss the question as to preventive measures.

## 2. The Færoes.

Although the halibut fishery round the Færoes does not attain the same importance as that of Iceland, the halibut is nevertheless a considerable item in the haul of the trawlers and line vessels fishing in these waters. The annual yield of halibut cannot, as mentioned, compare with that of the Iceland waters, but the fishery and its methods are otherwise precisely the same, only on a smaller scale. Here, as in the case of the Iceland fishery, the amount of line-caught fish far exceeds that taken by the trawl.

### A. The native industry.

The native fishery of the Færoes falls, as we know, generally into two periods, one in the first half of the year in Færoe waters, and the other during summer off the coasts of Iceland. During both periods, halibut are taken on the line, but this fishery is of subordinate importance, and on the whole we may say that the amount of halibut taken by Færoe fishermen is but slight. Some figures from the Danish Fishery Reports will bear this out.

| | Quantity | Value |
|---|---|---|
| 1911..... | 8510 kg | 999,00 Kr. |
| 1912..... | 18525 - | 4925,00 - |
| 1913..... | 10695 - | 1646,00 - |
| 1914..... | 4103 - | 820,60 - |

### B. Foreign fishery in Færoe waters.

As in the case of Iceland, so also at the Færoes we find that foreigners take the greater part of the rich yield, and here again, England is the dominant country as regards the halibut fishery. The fishery is carried on partly from steam trawlers and partly from line steamers, the most important season being during the winter months, due to the fact that a number of the same vessels are working the Iceland grounds during summer. Most of the trawlers and line vessels are from England and Scotland, but also German, Norwegian, Dutch and Belgian trawlers also work here.

**Yield of Halibut Fishery at the Færoes 1903—1910.**

| | England | Scotland | Nether-lands | Total Quantity |
|---|---|---|---|---|
| 1903..... | .. | .. | 894 | .. |
| 1904..... | .. | 142,697 | 300 | .. |
| 1905..... | .. | 174,219 | 14,105 | .. |
| 1906..... | 1,970,684 | 60,960 | 5,840 | 2,037,484 |
| 1907..... | 2,169,465 | 73,376 | 9,758 | 2,252,599 |
| 1908..... | 1,810,106 | 233,934 | 7,602 | 2,051,642 |
| 1909..... | 1,620,114 | 410,769 | 14,563 | 2,045,446 |
| 1910..... | 1,036,980 | 345,626 | 2,448 | 1,385,054 |

We have no exhaustive statistics as to the hauls made by the ships of these various nations; in the case of the English and Scottish vessels, however, statistical information for a number of years is available. The figures in the "Bulletin Statistique des pêches maritimes des pays du nord de l'Europe", issued by the International Marine Investigations, cover the years 1903—1910 and show the yield for England, Scotland and the Netherlands as stated above.

Taking the total hauls for the period 1906—1910 the amounts for the three countries are as follows:

England..... 8,607,349 kilos.
Scotland..... 1,124,665 -
Netherlands..... 40,211 -

This shows how predominant is the English fishery in comparison with that of other countries, but the English halibut fishery at the Færoes is by no means comparable with the amount taken by the same country on the Iceland grounds. The Færoe fishery for these 5 years represents 8,607,349 kilos, whereas the Iceland fishery for the same period amounted to 29,217,722 kilos. In other words, the Iceland halibut fishery gives, as far as England is concerned, three and a half times as much as that of the Færoes. A

similar comparison in the case of Scotland shows that the difference in the halibut fishery of the two localities is here less pronounced. The yield of the Scottish fishery at the Færoes during the five years was 1,124,665 kilos, as against 1,190,163 kilos from Iceland.

It will be interesting to study further the English statistics for the Færoe fishery, in the same manner as with that of Iceland. Statistics are available for the years 1906—1914. The last-named year is here included, but the figures are noted in parentheses, as we cannot be sure that the yield for that year was not in some degree affected by the outbreak of war.

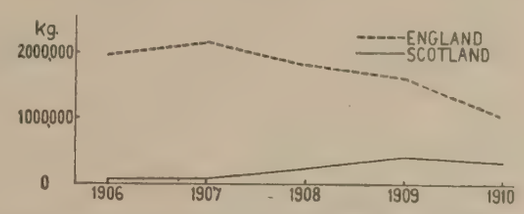



Fig. 11. Graph showing yield of English and Scottish Halibut fishery at the Færoes 1906—1910. [1])

It will be noticed that even disregarding the relatively small yield in 1914, there is nevertheless a decided falling off in the yield since 1907. This is even more markedly apparent in the accompanying graphical chart, showing the total yield for the various years (Fig. 12).

**English Halibut Fishery at the Færoes 1906—1914.**

| | Trawlers kg | Liners kg | Total kg | Percentage taken in each region % | Proportion per cent of Halibut to Quantity of demersal Fish. | Average catch per day's absence: Trawlers kg | Average catch per day's absence: Liners kg |
|---|---|---|---|---|---|---|---|
| 1906..... | 577,240 | 1,393,444 | 1,970,684 | 23.83 | 6.27 | 33.52 | 284.48 |
| 1907..... | 487,985 | 1,681,480 | 2,169,465 | 20.51 | 6.40 | 28.96 | 358,14 |
| 1908..... | 251,816 | 1,558,290 | 1,810,106 | 18.05 | 8.88 | 21.84 | 381.51 |
| 1909..... | 357,531 | 1,262,583 | 1,620,114 | 19.63 | 5.23 | 22.86 | 358.14 |
| 1910..... | 393,243 | 643,737 | 1,036,980 | 14.81 | 3.53 | 22.35 | 215.90 |
| 1911..... | 364,033 | 393,497 | 757,530 | 10.90 | 2.48 | 20.32 | 178.31 |
| 1912..... | 301,650 | 488,137 | 789,787 | 13.34 | 2.48 | 16.26 | 187.45 |
| 1913..... | 368,300 | 452,425 | 820,725 | 15.50 | 2.45 | 16.76 | 195.58 |
| (1914..... | 274,879 | 294,640 | 569,519 | 14.17 | 2.04 | 13.20 | 171.70) |

We find here just the same state of things as in the case of the Iceland fishery. The total yield has since 1906—07 decreased to over half. Comparing the yield for the two periods of three years each, from 1906—08 and 1911—13, we find 5,950,255 and 2,368,042 kilos respectively. Taking the total yield for trawlers and for liners separately, we obtain the same impression as in the Iceland fishery. The yield of the trawlers is in all essentials constant, the entire decrease being borne by the line fishery.

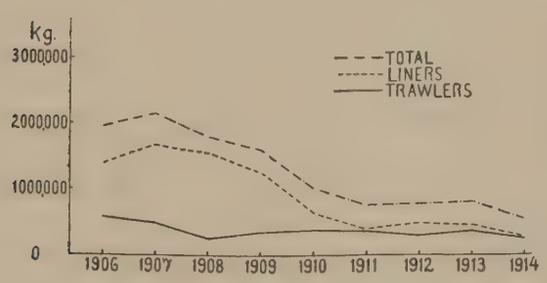



Fig. 12. Graph showing English Halibut fishery at the Færoes 1906—1914.

Again, if we consider the average haul per day's absence, as previously done in the case of Iceland, we here find confirmation of the view that the great decline in the total yield is due to a falling off in the average take per day's absence. This will be seen from the curves given below (Fig. 13), covering the period from 1906—14.

The English halibut fishery at the Færoes thus shows a corresponding decline in the yield to that noted in the Iceland waters, and a further investigation of the Scottish fishery will likewise be found to agree in all essentials with the results of the Iceland fishery.

[1] The curve for the Netherlands not marked, owing to the extreme smallness of the yield.

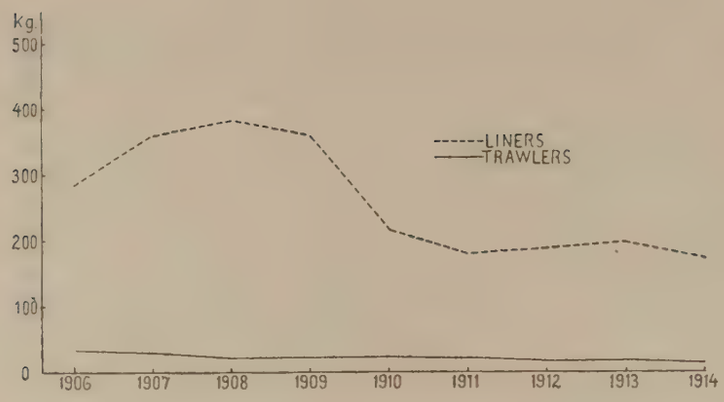



Fig. 13. Average catch per day's absence. English Halibut fishery at the Færoes. 1906—1914.

The Line and Trawl fishery may be treated separately, in the same way as with the Scottish fishery in Iceland waters.

The Scottish line fishery at the Færoes for the years 1908—15 gives the following mean values for number of trips and number of lines during the different months.

The average monthly yield per 100 lines fishing amounted during the different years to the following (in cwts.) (*vide infra*).

A graphical illustration of the mean values for the years 1908—11 and 1912—15 (Fig. 14) shows, that the yield per 100 lines fishing has decreased very considerably during the latter period, although the falling off is not so marked as in the case of the Scottish line fishery on the Iceland grounds.

**Aberdeen Liners. Færoes.**

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Ann. Mean. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of Trips .... | 3.6 | 7.2 | 10.3 | 8.4 | 7.3 | 12.7 | 17.4 | 9.6 | 9.0 | 7.1 | 6.9 | 7.1 | 8.9 |
| No. of Lines .... | 397 | 862 | 1246 | 1013 | 1033 | 1867 | 2372 | 1438 | 1162 | 909 | 785 | 786 | 1156 |

**Average monthly yield in cwts. per 100 lines fiching, for Aberdeen liners at the Færoes. 1908—1915.**

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Ann. Mean. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1908..... | 9.1 | 14.5 | 30.0 | 38.7 | 41.0 | 71.1 | 62.6 | 41.2 | 40.5 | 45.9 | 35.7 | 12.2 | 36.9 |
| 1909..... | 17.0 | .. | 20.8 | 38.6 | 80.8 | 69.4 | 69.1 | 60.0 | 62.1 | 36.8 | 29.5 | 15.9 | .. |
| 1910..... | 8.4 | 15.4 | 18.6 | 37.3 | 56.4 | 68.3 | 55.3 | 39.2 | 46.3 | 62.2 | 24.4 | 10.9 | 37.4 |
| 1911..... | 27.8 | .. | 28.1 | 39.6 | 38.2 | .. | 44.9 | 43.8 | 33.9 | 26.6 | 21.3 | 10.3 | .. |
| 1912..... | 7.8 | 12.6 | 21.5 | 24.0 | 27.7 | 42.4 | 37.7 | 32.8 | 32.6 | 21.3 | 13.1 | 11.2 | 23.7 |
| 1913..... | 11.1 | 17.2 | 18.2 | 29.8 | 34.8 | 44.3 | 35.9 | 34.6 | 35.5 | 15.5 | 30.8 | 10.4 | 26.5 |
| 1914..... | 14.4 | 21.4 | 21.1 | 31.5 | 30.7 | 35.9 | 41.7 | 41.7 | .. | 34.8 | 28.3 | 22.9 | .. |
| 1915..... | 7.8 | 13.3 | 14.8 | 30.4 | 40.0 | 57.8 | 43.3 | 32.9 | .. | .. | .. | .. | .. |
| Mean..... | 13.0 | 15.7 | 21.6 | 33.7 | 43.7 | 55.6 | 48.8 | 41.8 | 41.8 | 34.7 | 26.1 | 13.4 | 32.5 |

**Aberdeen Trawlers. Færoes.**

| | Jan. | Febr. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Ann. Mean. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of Trips..... | 9.8 | 15.4 | 36.5 | 41.4 | 29.5 | 26.8 | 27.0 | 14.9 | 15.1 | 9.1 | 4.1 | 8.3 | 19.8 |
| No. of Hours.... | 662 | 1121 | 2239 | 2410 | 1987 | 2076 | 2186 | 1240 | 1243 | 727 | 304 | 715 | 1409 |

An investigation of the yield of the Scottish trawl fishery at the Færoes likewise shows a tendency — albeit but relatively slight — to decrease during the last few years.

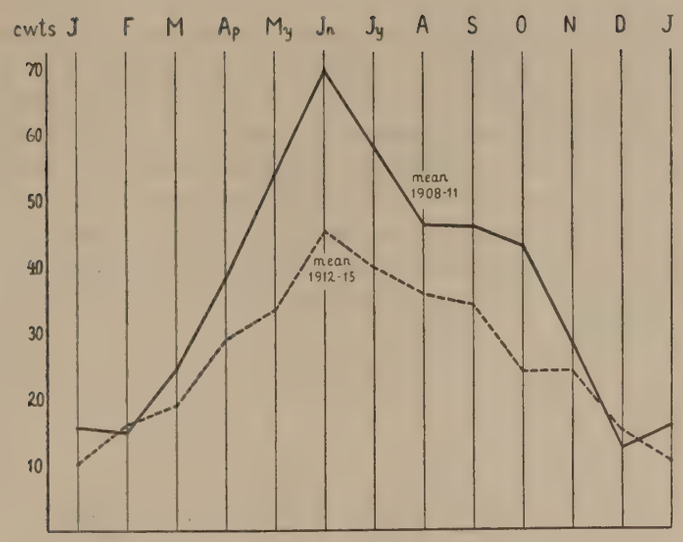



Fig. 14. Graph showing average monthly yield of halibut in cwts. per 100 lines fishing for years 1908—11 and 1912—15. Aberdeen Liners. Færoes.

The monthly share of the Aberdeen trawlers in the Færoe fishery will be seen from the figures p. 26, representing mean values for the years 1903—15.

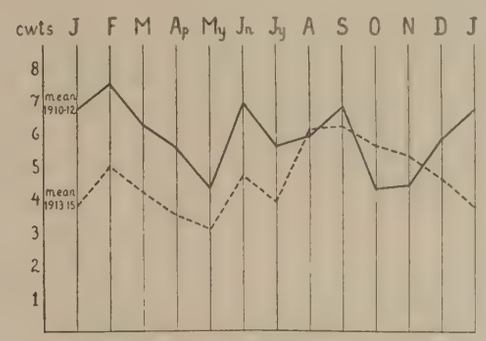



Fig. 15. Graph showing average monthly yield of halibut in cwts. per 100 hours fishing, for the years 1910—12 and 1913—15. Aberdeen Trawlers. Færoes.

The average yield in the different months per 100 hours fishing was as follows below (in cwts.).

The curves given Fig. 15 show the mean values for the yield per 100 hours' fishing during the different months of the three years 1910—12 and the similar period 1913—15, from which it will be seen that a decline, though relatively slight, is also discernible.

It will be seen from our consideration of the Scottish halibut fishery at the Færoes that this agrees, as regards its main features, with the English industry. Both Scottish and English line fishery show a conspicuous decline in the yield of halibut during recent years, while the trawling industry reveals but slight if any tendency to decline.

**Average monthly yield of halibut in cwts. per 100 hours fishing for Aberdeen trawlers at the Færoes. 1903—1915.**

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Ann. Mean. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1903 | 8.3 | .. | 5.0 | 9.2 | 10.7 | 8.6 | 24.4 | 19.8 | .. | .. | 22.9 | .. | .. |
| 1904 | 12.4 | 10.8 | 15.7 | 16.6 | 13.7 | 24.2 | 17.6 | 22.6 | 11.1 | 23.3 | 19.6 | 42.3 | 19.2 |
| 1905 | 6.2 | .. | 13.0 | 11.2 | 11.0 | 11.3 | 13.3 | 10.0 | 11.7 | .. | 27.2 | .. | .. |
| 1906 | 18.2 | 10.2 | 9.8 | 12.9 | 8.8 | 5.7 | 9.2 | 11.0 | 18.6 | 14.9 | 11.0 | 8.6 | 11.6 |
| 1907 | 8.2 | 6.5 | 9.9 | 9.1 | 6.8 | 11.3 | 9.2 | 9.6 | 13.3 | 11.6 | 6.0 | 8.5 | 9.2 |
| 1908 | 7.7 | 5.1 | 7.1 | 6.3 | 5.3 | 5.7 | 0.0 | 4.5 | 9.6 | 10.3 | 5.0 | .. | .. |
| 1909 | .. | .. | 7.1 | 6.5 | 5.2 | 10.5 | 12.4 | 8.2 | 6.2 | 10.3 | .. | 9.0 | .. |
| 1910 | 7.1 | 8.0 | 8.6 | 7.4 | 4.8 | 11.3 | 8.2 | 6.9 | 9.3 | 5.8 | 8.2 | 6.5 | 7.7 |
| 1911 | 7.6 | 7.9 | 6.1 | 6.0 | 4.9 | 5.7 | 4.9 | 7.6 | 7.9 | 5.2 | 1.7 | 6.6 | 6.0 |
| 1912 | 5.5 | 6.8 | 3.9 | 3.4 | 3.4 | 3.9 | 3.8 | 3.3 | 3.3 | 2.1 | 3.5 | 4.4 | 3.9 |
| 1913 | 3.8 | 5.8 | 4.6 | 4.1 | 3.3 | 3.9 | 3.5 | 5.4 | 5.3 | 4.4 | 4.2 | 3.5 | 4.3 |
| 1914 | 2.2 | 4.6 | 3.8 | 3.4 | 3.2 | 4.9 | 3.3 | 7.5 | 6.9 | 5.9 | 7.3 | 5.6 | 4.9 |
| 1915 | 5.5 | 4.6 | 4.2 | 3.1 | 3.0 | 5.4 | 5.1 | 5.4 | 6.4 | 6.6 | 4.4 | 4.8 | 4.8 |
| Mean | 7.7 | 7.0 | 7.6 | 7.6 | 6.5 | 8.6 | 8.8 | 9.4 | 9.1 | 9.1 | 10.1 | 10.0 | 8.5 |

The curves for the yield of the line and trawl fishery further show much the same course on the whole for the Færoes as for Iceland, and the remarks previously advanced with regard to such decrease in the case of the Iceland halibut fishery may also apply to that of the Færoes.

It will doubtless be necessary sooner or later to set on foot investigations with a view to ascertaining the cause of the considerable decline during recent years in the yield of the halibut fishery, in the Iceland and Færoe waters, and if possible, then to take such steps as may serve to restore the fishery of these localities. And if future investigations are to be based essentially upon statistical material, it will be most important, as already mentioned, to institute as soon as possible a system of classification for halibut, as the value of statistical information would thereby be greatly increased.

## V. Propagation of the Halibut, and Finds of Pelagic Post-larval Stages.

Marine research has not yet succeeded in discovering the eggs of the halibut in a free state, but it is hardly to be doubted that they are bathypelagic, and to be found at great depths, as is also suggested by the investigations of Dr. Johs. Schmidt on the finds of larval stages (*vide* Johs. Schmidt 1904 a). The earliest bottom stage of the halibut, on the other hand, are as yet unknown.

The spawning time of the halibut has been the subject of considerable discussion, but we can now doubtless assert, that the general spawning season falls in the first months of spring, prob-

**List of localities where pelagic post-larval stages of halibut (Hippoglossus vulgaris Flem.) have been caught. "Thor" 1904, 1905, 1908.**

| Station No. | Date | Position | Depth Meters | Temperature | | Gear | Min. | Length m/m |
|---|---|---|---|---|---|---|---|---|
| | | | | Surface | Bottom | | | |
| 100 | 22/5 04 | 61° 21′ N, 10° 59′ W | > 1000 | 8° 50 | — | Y. 15 Meters | 30 | 13.5 |
| 113 | 24/5 04 | 63° 31′ N, 16° 06′ W | 116 | 8° 01 | 7° 22 | Y. 15 — | 20 | 24.5 |
| 151 | 19/6 04 | 65° 25′ N, 27° 30′ W | ca. 750 | 7° 65 | — | Y. 15 — | 15 | 29.5 |
| — | — | — — | — | — | — | Y. 70 — | 15 | 22.0, 24.5 |
| 152 | 19/6 04 | 65° 00′ N, 28° 10′ W | 1240 | 8° 30 | 4° 00 | Y. 1000 — | 30 | 25.0 |
| — | — | — — | — | — | — | Y. 200 — | — | 22.0 |
| 153 | 20/6 04 | 65° 20′ N, 27° 12.5′ W | 740—768 | 7° 87 | 0° 10 | Y. 820 — | 30 | 27.0 |
| 154 | 20-21/6 04 | 65° 27′ N, 27° 10′ W | 700—765 | 7° 71 | — | Y. 50 — | 240 | 23.0 |
| — | — | — — | — | — | — | Y. 15 — | 60 | 16.5 |
| — | — | — — | — | — | — | Y. 80 — | 60 | 19.5, 22.0 |
| — | — | — — | — | — | — | Y. 75 — | 180 | 16¼, 18, 19, 19¼, 19½ |
| 155 | 21/6 04 | 65° 28′ N, 26° 20′ W | 223 | 7° 69 | 5° 78 | Y. 15 — | 30 | 22.0 |
| 173 | 7/7 04 | 64° 07′ N, 22° 39′ W | 44 | 10° 70 | 8° 61 | Y. 50 — | 20 | 34.0 |
| 58 | 26/5 05 | 63° 07′ N, 16° 12′ W | 1475 | 8° 05 | ca. 3° 49 | Y. 65 — | 150 | 19.5, 29.0 |
| 60 | 28/5 05 | 61° 50′ N, 11° 38′ W | 1110 | 8° 62 | ca. 3° 07 | Y. 25 — | 30 | 26.0 |
| — | — | — — | — | — | — | Y. 65 — | 150 | 20, 21 |
| 64 | 30/5 05 | 59° 17′ N, 7° 29′ W | 895 | 9° 88 | 7° 93 | Y. 25 — | 30 | 16, ca. 18 |
| — | — | — — | — | — | — | Y. 65 — | 60 | 22, 28.8 |
| 72 | 8-9/6 05 | 57° 52′ N, 9° 53′ W | 1020—1550 | 10° 72 | — | Y. 100 — | 120 | 28 |
| 22 | 31/5 08 | 59° 10′ N, 13° 13′ W | > 1655 | 9° 5 | — | Y. 65 — | 30 | 26.0 |
| 23 | 1/6 08 | 59° 43′ N, 14° 07′ W | > 1500 | 9° 1 | — | Y. 65 — | 30 | 22.9 |
| 24 | 1/6 08 | 60° 31′ N, 15° 22′ W | > 1500 | 8° 8 | — | Y. 100 — | 30 | 26.0 |

ably February—April. This corresponds well enough with the finding of post-larval stages in May—July, as also with the relatively few known finds of spawning fish. EHRENBAUM (1905) writes as follows: "Die Laichzeit fällt in der Nordsee (?) und an den skandinavischen Küsten in die Zeit von Ende Februar bis Mai, besonders April bis Anfang May, bei Island in den Juni bis August." This statement, however, I consider to be not a little doubtful, as the young post-larval stages of 13—14 mm. should in such case be $^3/_4$ to 1 year old. As regards the spawning time in the northern part of the North Sea, H. C. WILLIAMSON, (1906) who presumes that the fish spawn there, writes: "The present records extend the spawning period for the northern part of the North Sea to five months viz., January to May." This statement is based on the finding of mature specimens from the area in question.

Since the publication, in 1904, of Dr. JOHS. SCHMIDT's report on the first finds of pelagic post-larval halibut young, 13 pelagic specimens have been found in the same area in the course of the investigations on board the marine research steamer "Thor" in those waters during 1905 and 1908. The total amount of material, of which a survey is given above (p. 28), thus includes 32 specimens of these post-larval stages, varying between 13.5 and 34 mm. and taken between the 22nd May and 7th July.

Considering the great number of pelagic hauls which have been made in these waters, it is not a little surprising that so few of these stages should have been found. One explanation may possibly be that the stages in question presumably spread over a considerable vertical distance in the water.

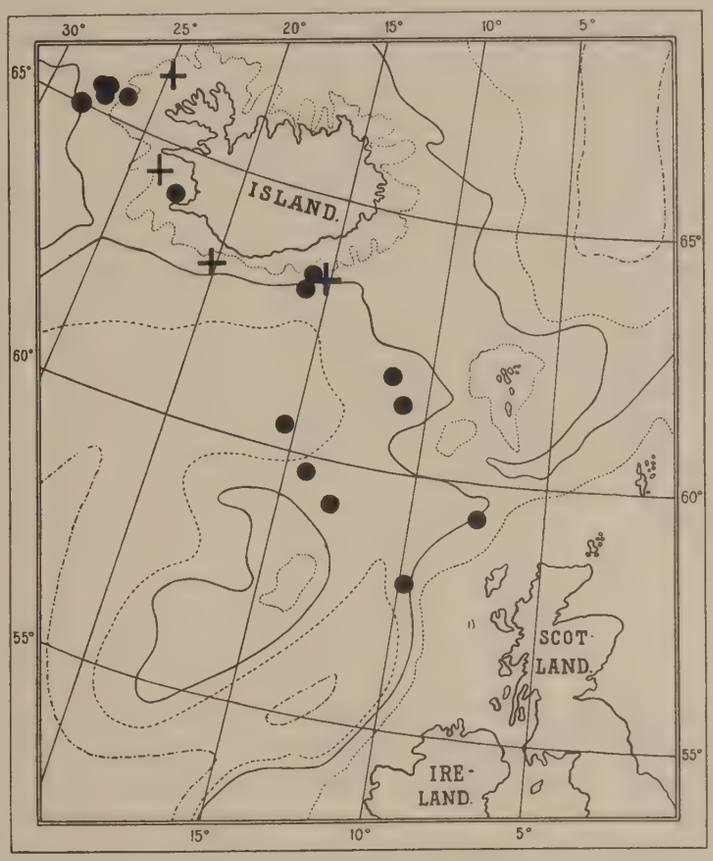



Fig. 16. Chart showing localities where post-larval stages of Halibut were found, or spent fish taken.
● Finds of pelagic post-larval stages of halibut.
+ Spent fish taken.
····· 200 Meter. ——— 1000 Meter. ------ 2000 Meter. ------- 3000 Meter.

The localities for these finds of pelagic stages will be seen from the accompanying sketch chart (Fig. 16), showing the very characteristic distribution between Scotland and Iceland. All the larval stages were found in water with great depth to bottom, most of them even beyond the 1000 metre line. The distribution seems decidedly to indicate that the halibut spawn in the Atlantic off the coasts of Scotland-Færoes-Iceland about or possibly even beyond the 1000 metre line, and shows at the same time that these fish seek deeper water for their spawning than the remaining flatfish of economical importance.

The present material is not sufficient to show more fully the course of the developement, but it is interesting to note the apparently great agreement between the pelagic young of the halibut and the pelagic larval stages of *Molva byrkelange* (*vide* JOHS. SCHMIDT 1909, Chart VII).

As we know, no larvæ of the halibut have ever been found in the North Sea or in the Norwegian

Sea. It is however, considered likely by many that the halibut spawn on the coasts of Norway It is probably more doubtful whether they do so in the North Sea. Nor would it seem likely that the entire stock of halibut both in the North Sea and Norwegian Sea should be derived from the Atlantic, but the possibility is not excluded until larval stages have been encountered in these waters.

Several points, by the way, seem to suggest that the halibut really do spawn at very considerable depths in the Atlantic. On the cruises of the "Thor" some few specimens of halibut were taken which had undoubtedly spawned. Characteristic of these specimens was the fact that they were very large individuals, and also that they were for the most part found above relatively great depths. The only specimen which was spent was even taken on a halibut hook at a depth of 920 metres (see chart p. 29).

We have in all records of 4 female halibut found in decidedly spent condition. The total lengths of these fish were 137, 144, 160 and 174 cm. This agrees well with the investigations of H. C. Williamson (1906) who found "full" halibut or specimens with mature eggs of the following total lengths: 127, 130 and 175 cm. Judging from these results, it must be presumed that the halibut do not become mature before 9—10 years of age at earliest.

By way of comparison it may be noted that the halibut on the Pacific coast, where, as we know, an intensive halibut fishery is carried on, do not reach maturity until the 8th year at earliest, and 50 % of the specimens examined not until the 12th. (W. F. Thompson 1914). The investigations there are based upon a large quantity of material, and there does not seem to be any marked difference between the halibut of the Atlantic coasts and the Pacific coast in this respect. From the investigations quoted, it appears that maturity is altogether dependent upon age, but not at all upon the size of the fish.

# VI. Summary.

The present work is based upon the journals from the cruises of the "Thor" to the Færoes and Iceland in the years 1903—1906, during which occasional investigations were made as to the biology of the halibut. In addition, during 1908 the first year in which otoliths and bones from these waters were used for age determinations, systematic collection and investigation was carried on with a view to elucidation of the biology of the halibut. The material of otoliths collected on these cruises has since been supplemented by material procured by Adjunkt Bjarni Sæmundsson, and Captain G. Hansen, who was in Iceland during the summer of 1909, added likewise to the material of halibut otoliths. The statistical information is derived partly from the Fishery Reports of the various countries, partly from the hitherto published volumes of the "Bulletin Statistique des pêches maritimes des pays du Nord de l'Europe". In addition, detailed statistics have been received concerning the Scottish halibut fishery of the Færoes and Iceland, through the Fishery Board for Scotland, Edinburgh.

The age determinations are based exclusively upon otoliths. The total material of these represents 2921 halibut, either from the west of Iceland or from East Iceland. These regions have been separately dealt with, as it was found that the growth of the halibut takes place at a considerably more rapid rate on the west coast than on the east coast of Iceland. The reason is probably to be sought in the differing hydrographical conditions, temperature being probably the factor of most decisive importance in this respect.

A difference is also observable in the growth of the two sexes, the male being relatively smaller than females of the same year group.

Both at Iceland and the Færoes, an intensive halibut fishery is carried on, partly by line fishing and partly by trawling. The yield of the line fishery consists mostly of large fish, the trawlers taking almost exclusively small specimens. The economical importance of the former industry far exceeds that of the latter. The total yield of the halibut fishery for the five years from 1906—10 was for the Iceland waters abt. 35 million kilos, at the Færoes abt. 10 million kilos. In both places, by far the greatest yield falls to the English vessels there engaged.

The English statistics embrace the period from 1906—14, and closer investigations shows, that the yield of the halibut fishery both at Iceland and the Færoes has greatly decreased during the past 5—6 years. Within this period, the total yield has dwindled to half or less than half. The average catch per day's absence shows a corresponding reduction. Both the total yield and the average haul per day's absence are found to be preeminently diminished in the case of line steamers alone, the reduction of the trawl catches being relatively insignificant. The information available with regard to the Scottish fishery points essentially in the same direction as in the case of the English. As possible causes of the decline in the yield are cited, 1) Temporary fluctuation, 2) Transference of craft from halibut to cod fishery, or 3) A reduction in the stock of halibut due to overfishing. As a number of English vessels have of late years been chiefly occupied in cod fishing on Iceland grounds, where the stock of halibut is at a minimum, there is much to suggest that this may to some extent at least be responsible. The modern trawling methods, however, destroy large quantities of immature halibut, and it is therefore not unlikely that the intensive fishery has partly conduced to the decrease in the yield. Further investigations will be necessary with regard to this point. A classification of the halibut in the statistics would be highly desirable for the sake of such future investigations, as rendering the material far more valuable than at present.

Since the finds published in 1904 (Johs. Schmidt 1904 a) of pelagic post larval stages of halibut, thirteen more specimens have been taken in 1905 and 1908, total lengths ranging from 16 to 29 mm. All were found in the Atlantic over great depths, and serve, together with the previous finds, to support the view that the halibut spawn in the Atlantic off the coasts of Scotland—Færoes—Iceland, near or beyond the 1000 metre line. The spawning season probably falls in the months of February—April.

The journals of the "Thor" contain only records of 4 female halibut found in a decidedly spent condition. Characteristic for these was the large size in all cases (over 130 cm) as also the fact of their being taken at relatively considerable depths. From the size of the fish in question, it would seem that the halibut do not attain maturity until an age of 9—10 years.

# VII. Literature References.


Annual Report of the Fishery Board for Scotland. 1906—1915. Edinburgh 1907—16.

Annual Report on Sea Fisheries for the years 1906—1914. Board of Agriculture and Fisheries. London 1908—15.

Bulletin Statistique des pêches maritimes des pays du nord de l'Europe. 1906—1910. Conseil permanent international pour l'exploration de la mer. Volume III—VII. Copenhague 1909—1914.

Collins, J. W. (1886). The Icelandic Halibut Fishery. Report of the Commissioner of Fish and Fisheries for 1884. Part. XII. Washington 1886.

Ehrenbaum, E. (1905). Eier und Larven von Fischen des nordischen Plankton. Kiel und Leipzig 1905.

— (1910). Eier und Larven von Pleuronectiden der Nordsee und benachbarter Gewässer, neuere Untersuchungen aus den Jahren 1904 bis 1909. Rapports et Procès-Verbaux du Conseil international pour l'exploration de la mer. Vol. XII, Copenhague 1910.

— (1911). Die Plattfischlarven der Nordsee und benachbarter Gewässer nach Zeit und Ort ihres Vorkommens, ibid. Vol. XIII, Copenhague 1911.

Fiskeri-Beretning for Aarene 1911—14. København 1912—15.

Fulton, T. W. (1905). Report on the distribution and seasonal abundance of flatfishes (Pleuronectidae) in the North Sea. Report on fishery .and hydrographical investigations in the North Sea and adjacent waters. North Sea Fisheries Investigation Committee. 1902—1903 Vol. I. London 1905.

— (1913). On the distribution and seasonal abundance of flatfishes (Pleuronectidae) in the North Sea, and the fluctuations in their abundance during the years 1901—1910. Fishery Board for Scotland. Fifth Report (Northern Area) on fishery and hydrographical investigations in the North Sea and adjacent waters. 1908—1911. London 1913.

Heincke, Fr. (1916). Neue Forschungen über Alter und Wachstum der Schollen. „Der Fischerbote" VIII Jahrg. Nr. 7, 8. Hamburg 1916.

Landshagsskýrslur fyrir Ísland. 1897—1911.

Maier, H. Nic. (1906). Beiträge zur Altersbestimmung der Fische. I. Allgemeines. Die Altersbestimmung nach den Otolithen bei Scholle und Kabeljau. Arbeit. der Deutsch. wiss. Komm. für die internat. Meeresforschung. B. Aus der biologischen Anstalt auf Helgoland, Nr. 5. Oldenburg 1906.

Murrich, J. Playfair Mc. (1913). Notes on the Scale Markings of the Halibut and their bearing on questions connected with the conservation of the fishery. Transactions of the Royal Society of Canada. III Series. 1913. Vol. VII, Sec. IV.

Schmidt, Johs. (1904 a). On pelagic post-larval Halibut (*Hippoglossus vulgaris* Flem. and *H. Hippoglossoïdes* [Walb.]) Medd. fra Komm. for Havundersøgelser. Bind I. Nr. 3. København 1904.

— (1904 b). Fiskeriundersøgelser ved Island og Færøerne i Sommeren 1903. Skrift. udg. af Komm. f. Havunders. Nr. 1. Kbhvn. 1904.

— (1909). The distribution of the pelagic fry and the spawning regions of the gadoids in the North Atlantic from Iceland to Spain. Rapports et Procès-Verbaux du Conseil international pour l'exploration de la mer. X, Copenhague 1909.

Sæmundsson, B. (1909). Oversigt over Islands Fiske. Skrift. udg. af Komm. f. Havunders. Nr. 5. Kbhvn. 1909.

Thompson, F. W. (1914). A preliminary Report on the life-history of the halibut. British Columbia Fisheries Department, 1914 (Report of the British Columbia Commissioner of Fisheries, 1914).

Williamson, H. Ch. (1911). Notes on the eggs of the angler (*Lophius piscatorius*), Halibut (*Hippoglossus vulgaris*) etc. Twenty-eight Annual Report of the Fishery Board for Scotland. Glasgow. 1911.

# CONTENTS


I. Introduction ..... 3
II. Size of the Iceland Halibut (Length and Weight) ..... 5
III. Growth of the Iceland Halibut ..... 7
1. South-west Iceland ..... 9
2. North-west Iceland ..... 12
3. East Iceland ..... 14
4. Growth in Iceland waters generally ..... 15
IV. The Halibut Fishery of Iceland and the Færoes ..... 16
1. Iceland ..... 16
A. The Native Industry ..... 17
B. Foreign Fishery in Iceland Waters ..... 17
2. The Færoes ..... 24
A. The Native Industry ..... 24
B. Foreign Fishery in Færoe Waters ..... 24
V. Propagation of the Halibut, and Finds of Pelagic Post-larval Stages ..... 28
VI. Summary ..... 31
VII. Literature References ..... 32


## IMPORTANT CORRECTIONS

Page 9, line 8, for 2719 read 2179.
— 14. Weights of various age groups. Halibut from North-west Iceland for ♂ + ♀ read ♀ and for ♀ read ♂ + ♀.

# EXPLANATION OF PLATE

Otoliths of halibut (*Hippoglossus vulgaris*, Flem.) from Iceland. Reproduced from photos by Pacht & Crone, taken in reflected light.

| | | | | |
|---|---|---|---|---|
| Fig. 1. | No. of growth rings: | 1— | length of fish 10 cm | Faxebugt. $^{18}/_{6}$ 08. |
| - 2. | - - - - | 2— | - - - 23 - | Weight 110 gr. ♀. Faxebugt. $^{10}/_{6}$ 08. |
| - 3. | - - - - | 3— | - - - 33 - | - 360 - ♂. - - - |
| - 4. | - - - - | 4— | - - - 52 - | - 1450 - ♀. - - - |
| - 5. | - - - - | 5— | - - - 60 - | ♀. Faxebugt. July 1909. |
| - 6. | - - - - | 6— | - - - 59 - | Weight 2190 gr. ♀. Off Patrexfjord. $^{14}/_{7}$ 08 |
| - 7. | - - - - | 7— | - - - 68 - | ♂. Faxebugt. July 1909. |
| - 8. | - - - - | 8— | - - - 67 - | ♂. - $^{18}/_{7}$ 09. |
| - 9. | - - - - | 9— | - - - 97 - | ♂. - July 1909. |
| - 10. | - - - - | 10— | - - - 80 - | Weight 5120 gr. ♂. Off Arnarfjord $^{17}/_{7}$ 08. |
| - 11. | - - - - | 18—20 | - - - 154 - | - 49000 - ♀. Faxebugt. $^{4}/_{7}$ 08. |

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

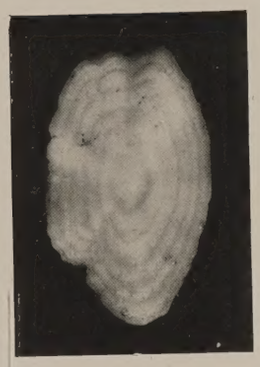


Fig. 6.

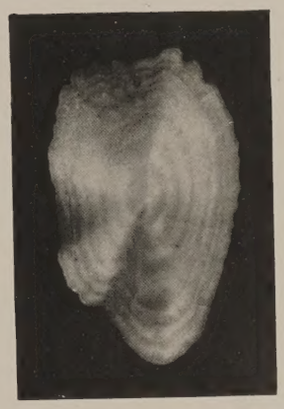


Fig. 7.

Fig. 8.

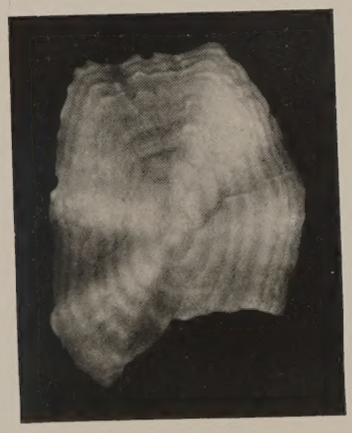


Fig. 9.

Fig. 11.

Fig. 10.

Otoliths of halibut (*Hippoglossus vulgaris*, Flem.) from Iceland.

*Pacht & Crone ad naturam phot.*

KBH. BIANCO LUNO

Bd. IV, Nr. 2 JOHS. SCHMIDT: On the identification of Muraenoid larvae. In their early (»Preleptocephaline«) stages. 1 Plate. 1913. 14 p. Kr. 0.75.

» IV, » 3 A. STRUBBERG: The metamorphosis of elvers as influenced by outward conditions. Some experiments. 1913. 11 p. Kr. 0.50.

» IV, » 4 A. C. JOHANSEN: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. VI. On the immigration of plaice to the coastal grounds and fiords on the west coast of Jutland. 1913. 26 p. Kr. 1.00.

» IV, » 5 P. L. KRAMP: Report on the fish eggs and larvæ collected by the Danish research steamer »Thor« in the Langelandsbelt in 1909. With 6 figures in the text. 1913. 39. p. Kr. 1.25.

» IV, » 6 BJARNI SÆMUNDSSON: Continued marking experiments on plaice and cod in Icelandic waters. 7 fig. 1913. 35 p. Kr. 1.25.

» IV, » 7 JOH. SCHMIDT: On the classification of the fresh-water Eels (Anguilla). 1915. 19 p. Kr. 0.75.

» IV, » 8 Ö. WINGE: On the value of the rings in the scales of the Cod as a means of age determination. Illustrated by marking experiments. 1915. 21 p. Kr. 0.75.

» IV, » 9 A. C. JOHANSEN: Contributions to the biology of the Plaice with special regard to the Danish Plaice-Fishery. VII. Marking experiments with Plaice in the North Sea off the west coast of Jutland during the years 1906—1912. With supplementary observations on the previous Danish experiments. 27 fig. 1915. 60 p. Kr. 2.00.

» V, » 1 JOHS. SCHMIDT: Marking experiments with Turtles in the Danish West Indies. 11 fig. 1916. 26 p. Kr. 1.00.

» V, » 2 A. C. STRUBBERG: Marking Experiments with cod at the Færoes. 24 fig. 1916. 126 p. Kr. 4.00.

» V, » 3 A. C. JOHANSEN: Marking Experiments with Sole (Solea vulgaris Quensel) and Turbot (Rhombus maximus L.) in the Kattegat and Baltic Waters. 4 fig. 1916. 18 p. Kr. 0.50.

» V, » 4 JOHS. SCHMIDT: On the early larval stages of the fresh-water Eels (Anguilla) and some other North Atlantic Murænoids. 4 Pl. and 14 Figures. 1916. 20 p. Kr. 1.75.

## Serie: Hydrografi.

Bd. I, Nr. 1 MARTIN KNUDSEN: On the organisation of the Danish hydrographic researches. 1904. 7 p.

» I, » 2 H. J. HANSEN: Experimental determination of the relation between the freezing point of sea-water and its specific gravity at 0° C. 1904. 10 p.

» I, » 3 N. BJERRUM: On the determination of Chlorine in sea-water and examination of the accuracy with which Knudsen's pipette measures a volume of sea-water. 1904. 11 p. Kr. 1.25.

» I, » 4 J. N. NIELSEN: Hydrography of the waters by the Faroe Islands and Iceland during the cruises of the Danish research steamer "Thor" in the summer 1903. 8 Plates. 1904. 29 p.

» I, » 5 NIELS BJERRUM: On the determination of Oxygen in sea-water. 1904. 13 p. Kr. 3.50.

Bd. I, Nr. 6 MARTIN KNUDSEN: Contribution to the Hydrography of the North Atlantic Ocean. 21 Plates. 13 p. Kr. 5.75.

» I, » 7 J. N. NIELSEN: Contributions to the Hydrography of the waters north of Iceland. 2 Plates. 28 p.

» I, » 8 J. P. JACOBSEN: Die Löslichkeit von Sauerstoff im Meerwasser durch Winklers Titriermethode bestimmt. 1905. 13 S. Kr. 2.00.

» I, » 9 J. N. NIELSEN: Contribution to the Hydrography of the north-eastern part of the Atlantic Ocean. 3 Plates. 1907. 25 p. Kr. 1.75.

» I, » 10 J. P. JACOBSEN: Mittelwerte von Temperatur und Salzgehalt. Bearbeitet nach hydrographischen Beobachtungen in dänischen Gewässern 1880—1907. 11 Tafeln. 1908. 26 S. Kr. 3.50.

» I, » 11 J. N. NIELSEN: Contribution to the understanding of the currents in the northern part of the Atlantic Ocean. 1 Plate. 1908. 15 p. Kr. 0.75.

» I, » 12 J. P. JACOBSEN: Der Sauerstoffgehalt des Meereswassers in den dänischen Gewässern innerhalb Skagens. 5 Tafeln. 1908. 23 S. Kr. 2.00.

» I, » 13 KIRSTINE SMITH: Gezeitenstroeme bei den Feuerschiffen Vyl und Horns Rev. Mit 4 Textfiguren. 1910. 23 S. Kr. 0.75.

» I, » 14 J. P. JACOBSEN: Gezeitenstroeme und resultierende Stroeme im Grossen Belt in verschiedenen Tiefen im Monat Juni 1909. Mit 7 Figuren im Text. 1910. 19 S. Kr. 0.75.

» II, » 1 MARTIN KNUDSEN: Danish hydrographical investigations at the Faroe Islands in the spring of 1910. 2 Plates. 1911. 17 p. Kr. 1.00.

» II, » 2 J. P. JACOBSEN: Beitrag zur Hydrographie der dänischen Gewässer. 47 Tabellen, 17 Textfiguren, 14 Tafeln. 1913. 94 S. Kr. 6.50.

» II, » 3 J. P. JACOBSEN: Strommessungen in der Tiefe in dänischen Gewässern in den Jahren 1909—1910 und 1911. Mittlere Werte des Stroms und Konstanten der Geseitenbewegung. 1913. 43 S. Kr. 1.25.

» II, » 4 J. P. JACOBSEN: Hydrographical investigations in Faeroe Waters in 1913. 15 fig. 1915. 47 p. Kr. 1.50.

» II, » 5 J. P. JACOBSEN: Contribution to the Hydrography of the Atlantic. 7 fig. 8 diagrams. 1916. 24 p. Kr. 0.75.

## Serie: Plankton.

Bd. I, Nr. 1 OVE PAULSEN: Plankton-Investigations in the waters round Iceland in 1903. 2 Maps. 1904. 41 p.

» I, » 2 C. H. OSTENFELD: On two new marine species of Heliozoa occurring in the Plankton of the North Sea and the Skager Rak. 1904. 5 p. Kr. 2.00.

» I, » 3 OVE PAULSEN: On some Peridineæ and Plankton-Diatoms. 1905. 7 p. Kr. 0.25.

» I, » 4 OVE PAULSEN: Studies on the biology of Calanus finmarchicus in the waters round Iceland. 3 Plates. 1906. 21 p. Kr. 1.75.

Bd. I, Nr. 5 Ove Paulsen: The Peridiniales of the Danish Waters. 1907. 26 p. Kr. 0.75.

» I, » 6 C. H. Ostenfeld: On the immigration of Biddulphia sinensis Grev. and its occurrence in the North Sea during 1903—07 and on its use for the study of the direction and rate of flow of the currents. 4 Charts and 5 Text-Figures. 1908. 44 p. Kr. 2.50.

» I, » 7 Aug. Brinkmann: Vorkommen und Verbreitung einer Planktonturbellarie *Alaurina composita* Mecz. in dänischen Gewässern. 12 Figuren und 1 Karte. 1909. 15 S. Kr. 0.50.

» I, » 8 Ove Paulsen: Plankton investigations in the waters round Iceland and in the North Atlantic in 1904. 9 Figures. 1909. 57 p. Kr. 1.75.

Bd. I, Nr. 9 Andreas Otterstrøm: Beobachtungen über die senkrechten Wanderungen des Mysisbestandes in der Ostsee bei Bornholm in den Sommermonaten 1906 und 1907. 1 Fig. 1910. 10 S. Kr. 0.25.

» I, » 10 C. H. Ostenfeld: A revision of the marine species of Chætoceras Ehbg. Sect. Simplicia Ostf. With 24 figures in the text. 11 p.

» I, » 11 J. P. Jacobsen and Ove Paulsen: A new apparatus for measuring the volume of plankton samples by displacement. 6 p. Kr. 0.50.

» I, » 12 P. L. Kramp: Medusæ, Ctenophora and Chætognathi. From the Great Belt and the Kattegat in 1909. 1915. 20 p. Kr. 0.75.

## SKRIFTER UDGIVNE AF KOMMISSIONEN FOR HAVUNDERSØGELSER

Nr. 1 Johs. Schmidt: Fiskeriundersøgelser ved Island og Færøerne i Sommeren 1903. 10 Tavler. 1904. VI + 148 S. Kr. 5.00. Udsolgt.

» 2 Martin Knudsen: Havets Naturlære. Hydrografi. Med særligt Hensyn til de danske Farvande. 10 Figurer, 4 Tavler. 1905. 41 S. Kr. 1.75. Udsolgt.

» 3 Johan Hjort og C. G. Joh. Petersen: Kort Oversigt over de internationale Fiskeriundersøgelsers Resultater med særligt Henblik paa norske og danske Forhold. 10 Tavler. 1905. 54 S. Kr. 3.50.

» 4 Martin Knudsen, C. G. Joh. Petersen, C. F. Drechsel, C. H. Ostenfeld: De internationale Havundersøgelser 1902—07. 1908. 28 S. Kr. 0.75.

» 5 Bjarni Sæmundsson: Oversigt over Islands Fiske med Oplysning om deres Forekomst, vigtigste biologiske Forhold og økonomiske Betydning. 1 Kort. 1909. 140 S. Kr. 2.25.

Nr. 6 Andreas Otterstrøm: Sildens Afhængighed af forskellige hydrografiske og meteorologiske Forhold i Store Bælt. 2 Textfigurer. 1910. 52 S. Kr. 1.00.

» 7 A. C. Johansen: Om Rødspætten og Rødspættefiskeriet i Beltfarvandet med nogle Bemærkninger om de øvrige Flynderarter og Flynderfiskerier i samme Farvand. 23 Tavler, 14 Textfigurer. 1912. 158 Sider. Kr. 3.00.

» 8 Johs. Schmidt: Danske Undersøgelser i Atlanterhavet og Middelhavet over Ferskvandsaalens Biologi. 3 Tavler, 5 Textfigurer. 1912. 33 Sider. Kr. 1.50.